UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

R-5 FSH 2409.26b

REFORESTATION HANDBOOK

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3.1 - ORDERING PLANTING STOCK. Order planting stock 1-1/2 to 2-1/2 years in advance of its use. For example, 1-0 available for outplanting in 1990 had to be ordered in the fall of 1988. If 2-0 stock was needed, the order should have been been placed in the fall of 1987. Order through the Forest Silviculturist for review by the Regional Office. Sufficient seed must be in the seedbank to produce the requested stock. Seed collected in the fall will normally not be available for sowing the following spring because of the time needed to complete seed extraction, cleaning, drying, testing, and storage. Forests requiring the spring sowing of recently collected seed need to notify the nursery as soon as possible.

Planting stock is available from a variety of sources. Exhibit 01 summarizes the availability by species of bare root and containerized seedlings for commonly used nurseries in California, Oregon, and Washington. Nurseries noted with an asterisk can provide bare-root seedlings for either spring or fall planting operations. Plan orders for fall planting stock in advance, as most nurseries are not routinely prepared to lift, pack, and deliver seedlings in the fall.

Exhibit 01 indicates that the Wind River nursery is not recommended for ponderosa, Jeffrey, or sugar pine seedlings. This assumes that the seed source is a Sierra Nevada seed zone.

Production of Douglas-fir at the Placerville nursery is considered to be unreliable due to varying climatic conditions.

Production of sugar pine at the Placerville nursery is likewise considered unreliable, but, in this case, due to varying distributions of endomycorrhizal reintroduction in the seedbed.

3.1 - Exhibit 01

Rankings of Forest Service Nurseries by Species, Stock Type, and Source

Numerical rankings extend from "1" (first chioce) to "4" (last choice). A rating of "4" indicates that the seedlings will still meet the Regional specifications. A rating of "NR" indicates that the nursery is not recommended for the species or stocktype. A rating of "?" means that there is insufficient information, at this time, for a clear judgement. When combined with a numerical rating, the rating is regarded as a best estimation. A rating of "UNR" indicates that the nursery is unreliable in meeting the specifications. The rankings are not based on cost. They are based on the ability to meet seedling orders and specifications.

		Nursery Ranking			
Stock Type		Humboldt	Placerville	Stone	Wind River
Ponderosa Pine	1-0	3	1	1	N/R
	2-0	N/R	1	1	N/R
	1-1	1	2	2	N/R
	Plug-1	1	2	2	N/R
Jeffrey Pine	1-0	3	1	1	N/R
	2-0	3	1	1	N/R
	1-1	1	2	2	N/R
	Plug-1	1	2	2	N/R
Sugar Pine	1-0	1	1	1	N/R
	2-0	1	1	1	N/R
	1-1	1	2	2	N/R
	Plug-1	1	2	2	N/R
Douglas-fir	1-0	1	UNR	1	-
	2-0	1	1	1	-
	1-1	1	2	2	-
	2-1	1	2	2	-
	Plug-1	1	2	2	-
White Fir	1-0	?	?	?	?
	2-0	1	2	2	?
	1-1	1	2	2	?
	2-1	1	2	2	?
	Plug-1	1	2	2	?
Red Fir	1-0	N/R	N/R	N/R	?
	2-0	2?	3	3	1?
	1-1	1	2	2	?
	2-1	1	2	2	?
	Plug-1	1	2	2	?
Incense-cedar	1-0	?	2	1	?
	2-0	2	2	1?	1?
	1-1	1	2	2	1?
	Plug-1	1	2	2	1?
Giant Sequoia	1-0	?	UNR	?	1?
	2-0	1?	2?	?	1?
	1-1	1?	2?	?	1?
	Plug-1	1?	2?	?	1?
West. White Pine	1-0	N/R	N/R	N/R	N/R
	2-0	?	2?	2?	1?
	1-1	1	2?	2?	1?
	2-1	1?	2?	2?	1?
	Plug-1	1	2?	2?	1?

The delivery of planting stock must coincide with the availability of sites prepared for planting. Stock orders must take into account the predicted completion of site preparation. Sites scheduled to receive only 1-0 stock are the easiest to predict successfully. Sites scheduled to receive 2-0, or a mixture of 1-0 and 2-0, are difficult to predict. Ranger Districts should initiate seedling orders after the unit has been harvested.

Fall planting requires that seedlings are lifted, packed, and planted within a matter of a few days. The Forest should advise the nursery that the seedlot to be sown is to be lifted in the fall. Later decisions may complicate the separate lifting operation. Maintain no more than a 2 to 3 day supply of planting stock to support fall planting. Make arrangements with the nursery to carry over unused planting stock to the following spring in the event of changes in plans.

3.2 - HANDLING PLANTING STOCK. Planted seedlings must be capable of growing new roots shortly after planting. Root growth capacity (RGC) is an index of a seedling's capacity to produce new roots. Field studies in California and Southern Oregon by Jim Jenkinson, PSW, have shown that seedling survival is closely related to RGC at the time of planting. Many factors affect RGC. These factors include species, seed source, nursery, location, nursery practices, seedling handling, and cold storage (when used). The time of lifting and proper cold storage are key factors. In general, seedlings lifted and stored between early December and late February will have high RGC values after cold storage. For example, for true fir sites, typically snow covered until June, seedlings lifted in December or January, and properly stored, will survive and grow better than seedlings lifted in March. Once the nursery soil warms and root growth begins, RGC drops significantly. This reduces the probability of seedling survival. Seedlings lifted at the right time and stored properly, even for up to 6 months, will maintain acceptable RGC levels.

Plant moisture stress (PMS) is a measure of xylem water potential and an indicator of planting stock quality. Seedlings with high values have reduced abilities to extend root systems and have lower probabilities of seedling survival. Water potential in plants can be measured by Plant Moisture Stress Instruments ("pressure bombs"). The models that provide sufficiently accurate measurements for conifers use nitrogen gas stored in a pressurized cylinder, and cost about $1400-1800 (1990 prices).

Generally, water potentials lower than -5 bars (PMS values > 5 bars) in stock prior to planting indicate improper storage or handling, and questionable seedling survival. Five to ten bars may indicate adequate survival if the post-planting site conditions are highly favorable (for example, soil moisture levels at or near field capacity, little or no competing vegetation, cool air temperatures, low wind speeds, or high relative humidities).

Apply the following guidelines (3.2 - exhibit 01) to evaluate PMS values.

3.2 - Exhibit 01

PMS Evaluation Guidelines for Recently Planted Seedlings

		PMS Value	
Time of Day	Species	Ideal	Probable Trouble
Mid-day	PP/JP	< 8	>20
	DF	<11	>20
	WF or RF	<15	>20
Early-day	All	< 3	>10

Time of Day guidelines assume readings are being taken at the planting site during the planting window. Early-day readings (during the morning hours) are the more important diagnostic tools.

PMS values listed under the Probable Trouble category, that are relatively persistent for several days, may predict mortality.

Seedlings stored at temperatures in excess of 33° to 35° F (1° C) will rapidly respire and deplete the energy reserves needed for new root growth. High temperatures may also induce excessive moisture stress, or cause molds to form which may damage the roots and foliage. Molds do not always cause damage, but indicate that storage temperatures have been too high. Minimize moisture stress problems by using sealed polylined bags with adequate humidity.

3.21 - Transport and District Storage Guidelines. Follow these guidelines for cold storage and handling to maintain high RGC and low PMS in the planting stock.

1. Transport seedlings to the district in a refrigerated truck. Do not transport seedlings in uncovered bags piled in an open pickup in full sunlight on a warm day.

2. Avoid damage, or rough treatment, of the seedling containers. Minimize handling of planting stock during fall planting operations, as growing root tips are vulnerable to damage.

3. Delay transportation of recently lifted seedlings until seedling temperatures become lower. For spring plantings, hold the stock in the nursery cooler until the in-bag temperature is 33°-35° F before transporting to the district. For fall planting, in-bag temperatures (36°-38° F) are acceptable. Good truck coolers will hold low temperatures, but will not cool warm stock adequately.

4. Use sealed bags to maintain high humidity around the seedlings. This avoids the need to maintain high humidity within the cooler.

5. Repair damaged bags immediately to maintain humidity. Seal with tape that will hold under cold temperature conditions. Replace broken bags. If needed, add moisture to a bag, by moistening only the roots. Water on foliage and free water within the bag promotes mold.

6. Maintain temperatures inside the bag in the 33° to 35°F range for spring plantings. Temperatures in the 36° to 38° F range are acceptable during fall planting, but only if the stock will be planted within one month of lifting at the nursery. Attempt to plant within a week of lifting. Tree cooler air temperatures need to be a degree or two lower to achieve desired within-bag temperatures. Measure inside-bag temperatures with a dial thermometer that has a probe long enough to reach the center of the bag. Use a cooler with a continuous fan and a defrost cycle (prefab coolers are under GSA contract). Install an alarm on the cooler with a backup battery power supply. Post the telephone number of the person responsible for the cooler operation so that someone can be contacted if the cooler stops running, or if the ambient temperature exceeds the acceptable range. Consider installing a telephone alarm system (telephone calls are automatically made if the cooler stops running). Some coolers have a back-up refrigeration unit. Have a recording thermometer installed to measure cooler air temperature. Monitor temperatures with sufficient frequency to ensure maintaining proper in-bag temperatures. Reseal punctured or broken bags, as necessary.

7. Use rental refrigeration trucks when there are too many seedlings for the district cooler or for out-of-the-way projects. Be aware that in high humidity environments, cooler compressors can ice up. Ensure frequent monitoring (initially, at least daily) with this storage system to maintain the desired temperature. Consider adding a high-temperature alarm.

8. Do not let the bags alternately freeze and thaw. This extracts water from the seedlings and increases free water in the bags.

9. Do not plant "frozen" seedlings stored at temperatures less than about 26° F. Cellular damage from storage at low temperatures markedly affects survival. For seedlings stored at temperatures ranging from 28° to 30° F, thaw the seedlings at 34° to 36° F prior to planting. This slow thawing may take about a week.

10. Do not stack bags over two high without using spacers (or "stickers"). Good air circulation is essential to prevent heat build-up in the bags.

11. When receiving shipped seedlings, check the shipment carefully before signing the receipt. Record any conditions that indicate that the shipment is not in compliance with contract, or other specifications. Look for the following indicators of damaged planting stock:

a. Dry roots.

b. White root tips visible (elongation has begun). Except that for fall lifted stock, this is desirable.

c. Swollen or burst buds.

d. Presence of mold on needles or stems.

e. Physical damage (stem girdling, root stripping, lesions, stem swelling near groundline) and so forth.

f. Frozen seedlings.

g. Ripped or crushed bags.

12. Use the "pressure bomb" to sample for PMS for each seedlot. If seedlings do not meet the criteria described in section 3.2, document and consider destroying the stock. The true firs and sugar pine are more susceptible to moisture stress than other species.

3.3 - TIMING. Planting should occur as soon after site preparation as possible, preferably the following spring. Delaying a year decreases the effectiveness of the site preparation. If soil moisture is adequate, it is better to plant late in the first planting season than to delay the operation another year. If a two-year delay between harvest and planting is anticipated, perform the site preparation in the second year.

3.31 - Soil Conditions. Temperature and moisture conditions within the soil are of critical importance as they influence the seedlings ability to absorb water and to extend their root system.

3.32 - Temperature. Spring planting should begin when mid-day soil temperatures, at a 3" depth, are 40° F and rising. This guideline applies to all tree species. Do not plant at lower temperatures. Plant behind melting snow only if expecting the soil to warm to above 40° F within one week. Lower temperatures will inhibit soil water absorbtion and/or root elongation.

Fall planting should proceed only if it is reasonable to expect mid-day soil temperatures to be at or above 40° F, at a 3" depth, for two to four weeks after planting.

The period when soil temperatures are supportive of seedling establishment will vary from year to year, by physiographic region, slope position, aspect, and elevation. For spring planting operations, bud break generally occurs within a few to several weeks after root elongation. On sites with similar aspects, bud break at lower elevation sites may be a good indicator of favorable planting conditions at sites 500'-1,000' higher in elevation. Slope position and aspect may significantly influence when soils reach the 40° F threshold on sites of equal elevation.

3.33 - Moisture. Plant when the soil moisture content is near field capacity, preferably when soil moisture ranges between 0.1 and 0.5 bars of soil moisture tension. The soil should not be saturated. Where well prepared (for example, removal of most, or all, of the competing vegetation on the site), there is usually sufficient soil moisture for good root growth and survival. In the spring, the upper 1" or 2" of soil may dry out due to evaporation, but there is usually sufficient moisture below this depth to support seedling establishment. As root elongation essentially ends when shoot elongation begins, seedlings need to develop a root system adequate for survival prior to shoot elongation. This event, along with consideration of the soil environment, marks the end of spring planting.

Fall rains are essential to open a fall planting window. The top 12 to 15 inches of soil need to be at, or near, field capacity. Generally, the first fall rains do not produce sufficient moisture to adequately recharge soil to this depth. Examine historic precipitation patterns collected from a nearby weather station to assess the feasibility of a fall planting operation.

3.34 - Weather Conditions. Wind speed, air temperature, and relative humidity influence evaporative capacity. High evaporative capacity places stress on the seedling shoots and roots exposed during planting operations. High air temperature, high wind speed, and low relative humidity describe adverse planting conditions. See Planting weather guidelines developed in Oregon for Douglas-fir and ponderosa pine (Source: Cleary, Brian D., et al 1978, Regenerating Oregon's Forests, Oregon State University Extension Service. Pages 233-234). For true fir seedlings, until development of additional information, use the guidelines shown for Douglas-fir. Overall, these guidelines are too conservative, but do indicate conditions that may require mitigating measures to improve the chances for seedling survival. These might include "jelly rolling", using insulated bags, or confining the planting operation to the early morning hours. Note that planning for "jelly rolling" or use of insulated bags must be done in advance of the planting.

The quantity and quality of planting work will decrease in cold, stormy weather, for even the best planting crew. Weather conditions that reduce the effectiveness of the planting crew generally translate to reduced seedling survival and growth.

3.35 - Access. For spring planting, plant as soon as soil and weather conditions permit. Snow removal may be necessary to reach south or west facing sites that are free from snow. Road surfaces may not be able to support vehicle traffic during portions of the planting season without 4-wheel drive trucks.

If ground travel each day exceeds about two hours each way on bumpy roads, or if the roads cannot open before the planting window closes, consider using a helicopter to get equipment and planters to and from the planting sites. Excessive amounts of travel time on roads in poor condition can cause fatigue which will affect the quality of the planting job.

If 4x4s, snowcats, or other special vehicles may be needed, provide for them in the service contract. OSHA has special requirements for the use of any off-road and over-the-snow vehicles. The Forest Service is liable for any damages, or injuries, when contractors move personnel in fleet vehicles and helicopters.

If roads blocked by snow are plowable, provide for either Force Account or Service Contract clearing. Consult the Forest Engineer to develop appropriate specifications.

If vehicle access is unlikely, determine whether or not the stock and planting equipment can be hand-carried to the site.

Consider fall planting when access to isolated units or areas is difficult or costly because of weather or spring road conditions.

If the planters are to camp out, rent suitable vehicles and equipment, or require the contractor to provide them.

3.4 - CONTRACT OPTIONS. Contracting is an option for all types of planting. The FS can supply equipment. This is appropriate with nonstandard equipment like a machine or planting trays. Fall planting operations have been successfully carried out using a "grow and plant" contract with the nursery. In either spring or fall planting operations, it may be more practical to plant very small, scattered areas such as road pile areas by Force Account.

The FS typically uses Invitation for Bid procurements for the majority of cultural projects. Significant operational success has been achieved with this option.

Stewardship, or "end result", contracts are a relatively new type of procurement. They offer opportunities to obtain services based more clearly on Contractor abilities and to combine related activities into a single procurement.

Purchase Orders (Form AD-838) may be used for small projects. Include complete specifications in these type of procurements as well. The person signing the purchase order (PO) should get at least three realistic quotes. Do not use PO's to circumvent contracting. PO's are especially appropriate when unforeseen equipment problems or tree shortages occur, and the value does not exceed $10,000.

"Per acre" payments are commonly used in planting contracts. The total acreage to plant is known in advance and specfied in the contract. Inspection plots should confirm actual tree counts because planters often get paid by the tree.

"Per-tree" payments can divert attention away from minimal attainment of contract specifications described in per acre terms. It may be a better process to indirectly achieve higher tree numbers on each acre. The practice requires special attention to tree numbers. There are cases where planters bury, or otherwise waste, seedlings.

This payment method is especially easy to administer for replanting or planting in very scattered areas. It is easier to account for seedlings in these activities.

Carefully take plots to check the tree count in the entire area (including the unplanted areas). A better method is to pay according to the number of trees per acre based on plot data. An inspector should watch the crew at all times.

3.41 - Contract Preparation Lead Time. Prepare planting contracts as far in advance as possible. Generally, allow for 90 days between delivery to the S.O. and the award. For spring planting, issue the prospectus in the fall to allow for "show me" trips. These trips may be difficult to arrange if preparing the site in the fall, just prior to snowfall. For

fall planting contracts, begin assembling the contract in June or July and strive to award the contract prior to pile burning.

3.42 - Information Needs. Prepare clear, accurate maps. Provide unit maps during advertisement. This will allow potential bidders to locate the units by themselves. Post each unit clearly on the ground prior to advertisement. Show details such as different species mixes by area on the contract map.

Provide pesticide treatment history information, if requested.

Determine and state the estimated start work date. If the actual date may vary more than two weeks from this date, make this clear on the solicitation. If expecting a shutdown (for example, some high elevation sites may not be ready until a later date), add a statement to the solicitation.

Prior to submitting the contract, determine the estimated cost, the available funds (this is confidential information), species of seedlings to use, seed zones, seedling availability, expected lift dates, government-furnished property, and all supplemental specifications. A good cost estimate is critical in judging the bids, and a realistic daily production rate is the most important element in developing a good estimate.

Determine the time needed for the job. Allow for weekends, extreme weather, breakdowns and other delays. Keep this calculation in your contract folder. In the solicitation, state the number of days allowed due to extreme weather. If the contractor runs over the time and claims it was unreasonably short, the CO will want to know how the time was calculated. Also, the CO will use your diaries to determine diligence. Shorter contract times can lower administration costs, but can significantly reduce the number of available contractors, which may increase costs. Prepare a work progress schedule prior to the prework conference.

Determine potential camping places and any special requirements for the crew. A contractor doing business from a camp does not have the same privileges as a recreational camper. Consider the following pre-requisites to the use of a campsite: contractor hauls garbage to the dump, uses portable toilets, and has fire tools and 5 gallons of water in camp at all times. A mail box may also be desirable for messages and reports.

3.43 - Contract Specifications. Use the standard contract. The following are many not-so-common supplementary specifications to consider. Consider using them for Force Account work also.

1. Describe bare-root or container trees by size, species (only if known for certain), age, and minimum and maximum tap root lengths. This may require contacting the nursery to get information on the size and condition of your stock.

2. List all government-furnished property (for example, trees and packing material).

3. List contractor-furnished equipment where certain requirements must be met. Examples are hoedads with minimum blade sizes of 12", from tip to handle, or 4" diameter augers. List exclusions of certain types of equipment, if needed.

4. Include unit description, specifically noting when and how the site was prepared, and an estimate of how many acceptable established seedlings are now there.

5. Avoid packing snow on bare roots in the planting bag.

6. "Jelly-roll" all trees. This technique is recommended during adverse weather.

7. Restrict the number of trees that the planter can carry during dry weather.

8. Restrict the acceptable amount of overplanting.

9. Define "ground level" to ensure planting of seedlings to the correct depth.

10. Specify that trees will not be packed using a boot heel.

11. Define "rocky" ground.

12. Specify how to mix species (for example, every other tree or every other planter).

13. Define a plantable spot as a location where a tree can be planted to specifications.

14. The contractor's designated representative must be able to communicate orally with the inspectors or the COR - usually this means that they must be able to speak English fluently.

15. Consider requiring one non-planting supervisor on large projects (for example, one non-working supervisor per 7-10 planters).

16. Specify that planting bags should be empty of debris prior to each filling.

3.44 - COR Requirements. The COR must be someone well trained in contract administration and with experience in tree planting. They also should be on the site during most of the planting, carefully following the job.

3.45 - Prework Meeting. This section applies to both contract and Force Account work. Hold the meeting before the first workday. Review the contract, areas, and so forth, as noted in the following. The inspectors shall be present at this meeting. Explain responsiblities to them and the contractor. Advise the contractor of the authority of any other Forest Service personnel. Explain the lines of communication. Exchange phone numbers. Requests and complaints must be in writing. Get a written designation of contractor representative, describing exact

authority. Explain the inspection procedure, and invite the contractor to participate. Agree on a written work progress schedule.

Discuss everyone's safety. Explain such things as "the crew will not ride in the back of a government rig,". Explain the location of phones, radios, ambulances, hospitals, and helicopters, in case of an accident.

3.46 - Documentation. Record the following kinds of information on the Daily Diary:

1. Information about the contractor, including name of foreman, number of planters, arrival and departure time, hours worked, problems encountered, number of vehicles, and crew problems.

2. All discussions, including oral warnings, complaints, requests, descriptions of inspection results, threats, or intimidations. Include phone calls.

3. All deliveries.

4. Make a special note if the contractor deviates from the work progress schedule.

5. Inspection results, and follow-up work or directions issued.

6. All work orders or other written instructions.

7. Prepare a work progress map and keep it current.

8. All results of inspections of the contractor's campsite if it is on National Forest land. This should include trash disposal and sanitary facilities.

The COR must approve and initial all documents, including all inspection results. Standardize the routing and filing procedures for all documents. The COR must always be current on every detail. Forward all documents to the COR.

3.5 - PLANTING STRATEGY. Tree planting is the result of an analysis of the planting environment, the stand management objectives, and the recognition of successful techniques. Careless use of routine guidelines may result in failure to meet the objectives.

3.51 - Planting Density. The silviculturist determines planting densities and documents them on the stand record card (Form R-5 2400-205) and/or within the Stand Record System (SRS). Planting densities are most commonly described by reference to a square foot spacing objective. The actual distance between planted trees should be a function of predicted survival and the target tree size expected at a specific decade. Determine the target tree size needed to meet stand management objectives.

Sections 4.11a and 4.11b define minimum acceptable and recommended stocking levels for plantations.

Consider the following:

1. Precommercial thinning is a valuable technique to improve spacing and remove undesirable trees. Initial planting densities should provide for this by establishing seedlings at levels higher than those desired to attain the stand management objectives. For example, if desired to have tree spacings of about 14 by 14 feet to attain the first commercial thinning objective, planting spacing might be 7 by 14 feet. Precommercial thinning, along with mortality, would achieve the target spacing.

2. Make every effort to achieve survival and distribution objectives on the first effort. Higher planting densities typically cost less than replanting. This is especially true when requiring site prep for the replanting effort.

3. The selection of desirable planting spots is more important than obtaining a precise spacing pattern. Allow for variable distances between planting spots to obtain this. A typical method would be to provide for spacing tolerances up to 25%.

4. Natural regeneration may be an important component of the new stand. Consider it's presence, or the likelihood of it's presence, when developing planting specifications.

5. For plantations released or thinned mechanically, plant at spacings that will allow machine access.

6. When planting beneath shelterwood, specifications should ignore the presence of the trees to be removed. The impacts associated with the harvest may require the replanting of damaged areas.

3.52 - Field Transport and Storage. Insulated boxes (with or without refrigeration units) which fit pickup beds are available or can be constructed. Several Ranger Districts have developed effective portable coolers (for example, Amador R.D. on the Eldorado; Calaveras R.D. on the Stanislaus; and Cannell Meadow on the Sequoia). Increasing numbers of Ranger Districts are utilizing slip-on portable coolers with refrigeration units. Snow caching is another good way to store seedlings in the field. Storing bags in a 3-foot deep hole or snowbank, covered with "space blankets" has also proven effective. Use of a large fiberglass tub designed for wildlife development projects placed in a shaded snow drift also works well for seedling storage.

Apply the following guidelines to the transport and storage of seedlings:

1. Do not stack bags more than 2 high.

2. Keep the bags elevated off truck beds away from the influence of the catalytic converter using a pallet, platform, or some other insulation. If available, place snow around and over the bags, and cover them with a tarp, fire shelter, or insulating blanket.

3. Keep the bags away from gas and oil. "Oily" truck beds are bad places for seedlings.

4. Hold the inside-bag temperature below 35° F for true fir seedlings or below 38° F for Douglas-fir and pine seedlings during spring planting operations. Bag temperatures can be 1-2° F higher for these species during fall planting operations. Provide for air circulation around bags transported in refrigerated trucks.

5. If the inside-bag temperatures exceed 40° F, plant the seedlings within a few hours.

6. Provide full shade whenever possible during field storage. This will reduce energy consumption when using refrigeration units and may be the only means of maintaining desired temperatures using other field storage methods.

3.53 - Handling During Planting. The following recommended guidelines prevent root damage and facilitate high seedling survival rates.

1. Maximum root lengths are desirable, but plant them correctly to benefit from the length. The capabilities of typical planting tools restricts root length. The nursery typically prunes seedling roots for bare-root seedlings outplanted in the spring to 9" or 10" below the cotyledon scar, unless otherwise specified by the forest. Longer, more extensive root systems are generally desirable for seedlings to plant in the fall. Require pruning anytime that the planting method method is unable to correctly place the root system in the soil. If the pruned roots are too long, request that the contract inspector or trained Forest Service personnel do the repruning. Use a sharp paper cutter, or other tool, to prune roots. The pruned surface should be perpendicular to the root axis to minimize the amount of tissue involved. Pruned roots respond by increased cellular activity at the wound site, diminishing a portion of the stored carbohydrate, that would otherwise be available to support root elongation.

2. Load the seedlings in planting bags in the shade, even on cold days. Roots exposed to direct sunlight will have substantially increased foliar transpiration rates.

3. Use insulated, light-colored planting bags to keep seedlings cool during planting operations. Insulated bags may help keep seedlings from becoming too cool when ambient air temperatures are low during spring or fall planting.

4. Use the "jelly rolling" technique shown in exhibit 01, for spring planting in dry, warm, or windy conditions. This technique can be useful for fall planting operations as well. Take care to unroll the "jelly roll" before removing seedlings from the planting bag to avoid injury to actively growing root tips. See Section 4.2 for additional information on weather conditions.

SEE END OF THIS CHAPTER FOR SECTION 3.53 - EXHIBIT 01

5. If not using the "jelly rolling" method, wet the roots before placing seedlings in the planting bag. Various materials (absorbents or slurries) are available to add to water to increase the amount of water layer held around the dipped seedlings. Current research is not able to

accept, or reject, the benefits of this treatment. The water or slurry temperature should be at least 45° F, to ensure water uptake by seedlings. Avoid free water in the planting bag. It can interfere with root metabolism.

6. Place the seedlings in the planting bag so that each can be removed without root damage. Tight packing damages roots and buds. Actively growing roots are especially vulnerable during fall planting operations.

7. Carry a maximum of a two-hour supply of seedlings in a planting bag when planting in sunny conditions in the spring. Carry no more than about a one-hour supply (about 200 seedlings) when planting in the fall.

8. Do not remove the seedling from the bag or jelly roll until the planting hole is ready.

9. Carefully unroll the jelly roll each time a seedling is to be removed, to prevent root damage.

3.54 - Planting Spot Selection. Careful selection of planting spots is very important in achieving high survival and growth. The spot selected affects the seedling environment, planting quality, and the potential for animal damage.

Observe the following planting spot selection guidelines:

1. Plant in mineral soil. Do not plant in "duff" or decaying logs.

2. Avoid rocky spots where it is difficult to dig a deep planting hole. Proper root placement in these areas is difficult.

3. Plant in and around log piles and dead brush (except where expecting severe browsing by rabbits or hares.) Logs and dead brush provide shade and protection from some animals. This may reduce seedling transpiration and damage by deer, elk, or livestock. Avoid planting near logs or snags where bark may slough off and cover seedlings or near slash piles. See exhibit 01.

SEE END OF THIS CHAPTER FOR SECTION 3.54 - EXHIBIT 01

4. Plant in the vicinity of other living plants only if their scheduled removal occurs before compromising stand management objectives, or when they are a desirable component of the new stand.

5. Avoid planting on piles of loose soil. They may dry out quickly or can erode away easily, exposing seedling roots.

6. Road fills, berms, or cuts may remain unstable for several years. Seedlings planted in these areas are vulnerable to soil movement.

7. When planting in soil depressions, remove any unstable uphill material before leaving the planting spot.

8. Avoid planting in standing water, or depressions, which may hold water for several days, concentrate heat in summer, or fill with enough debris to bury seedlings.

9. Avoid planting game trails, unless using protective tubing.

10. Do not plant landings and skid roads when you anticipate harvest operations prior to the first entry planned for the replacement stand.

3.55 - General Procedures. See exhibit 01 for examples of unsatisfactory and satisfactory planting. Section 3.6 describes guidelines specific to particular hand planting tools. Consider the following general guidelines for a successful hand planting operation:

SEE END OF THIS CHAPTER FOR SECTION 3.55 - EXHIBIT 01

1. Remove litter, surface rock, other debris, live vegetation, and dry surface soil from the planting spot (within at least 1 foot from the planting hole). Scalp away organic material, snow, or dry soil before digging the planting hole. Scalping also removes seeds of competing plants. A very small scalp that removes dry soil from the planting spot, to avoid it's contact with the seedling root system, may be all that's needed. A larger scalp is necessary when vegetation control is a component of the planting process. See exhibit 02 for a description of a full bench scalp or terrace.

SEE END OF THIS CHAPTER FOR SECTION 3.55 - EXHIBIT 02

2. Center the planting hole in scalped area, or scalp additional ground to the required radius.

3. Dig deep planting holes, deeper than the maximum root length (usually the pruned tap root, often the longest primary laterals).

4. After the planting hole is ready, take just one seedling out of the bag. Never expose the roots for longer than is necessary to get the seedling from the bag into the hole.

5. Keep both the seedling and planting hole in the shade of the planter.

6. Place the seedling deep into the hole, with the roots hanging in their natural arrangement. Do not twist or bend the roots. Add some soil, then gently pull the seedling up until the foliage clears the ground line.

7. Plant the seedling so that its root collar is no more than 1 to 2" below the ground line. Do not cover the lowest needles.

8. Position the seedling between vertical and perpendicular to the slope. Avoid bending the seedling, firming the soil around it.

9. Never bend roots upward or force the seedling into the hole. Piling soil around shallow-planted seedlings does not work; the piled soil soon erodes. Prepare a new hole if the depth is not appropriate for the seedling.

10. Use only moist mineral soil to fill around the roots. Firm the soil at the bottom 1/2 to 1/3 of the hole, then fill and firm soil in the rest of the hole. Be sure that the soil is firm around the roots and that there are no air spaces. Take care not to damage roots while firming soil. The best tool is your ungloved hand, because you can feel the roots. Never use a stick.

11. Never put rocks, wood, dry soil, frost or snow in the hole. The snow will melt and leave "air pockets" around some of the roots.

3.6 - PLANTING METHODS. Several tools are available for tree planting. Each of them has special requirements and an appropriate environment to work within. Matching the one, or more, tools to the project is an important factor that can contribute to success.

3.61 - Auger Planting. A quality planting job is easier to achieve with auger planting that with any other method. The planting hole is more likely to be sufficiently deep and J or L roots are fewer than with any other method. An auger is especially useful for planting stock with large or long roots. Experiences in California vary, but generally the production rate for auger planting is about equal to that for hoe planting. Costs are typically higher. Exhibit 01 illustrates the steps in successful auger planting.

SEE END OF THIS CHAPTER FOR SECTION 3.61 - EXHIBIT 01

Consider the following auger planting guidelines:

1. Do not use an auger unless the soil is reasonably free of large rocks, slash, rotten wood and large roots.

2. If the slope is over 40%, evaluate for operator safety and prepare a detailed safety plan.

3. Use an auger bit that is at least 4" in diameter (over the length of the bit) so that soil can be hand-packed. The bit should be a premium, hardened bit (for example, carbide-tipped) to maximize effectiveness. Inspect the auger bit at least daily for excessive wear.

4. Use small non-vibration saws (rebrace handles), with a slow speed transmission, as a power source. This will allow for minimzing the distance that the loosened soil is thrown away from the rotating bit. Mound the soil around the lip of the hole. The saw should also have a chainbrake, so that a stuck auger can be unscrewed. Pulling out stuck augers wears on people and equipment.

5. Do not use augers with the gas tank and motor on the operator's back. Gas may leak on the operator. Also, it requires a second person

to start them. These models are heavy, vibrate, and can cause serious injuries if the operator falls. Also, communication is difficult between the operator and crew foreman, and with other crew members.

6. Direct the engine exhaust away from the body.

7. Avoid contaminating the planting hole soil with oil and gas from the chainsaw engine.

8. Organize the crew so that different people scalp, run the auger, and plant. Scalpers are responsible for locating and clearing away planting spots in rows. The auger operator works in a zig-zag pattern so planters have their own rows. Auger operation is tiring, so rotate jobs among the crew. Plant along the slope, so that the auger operator is contouring most of the time. This is less tiring work for the operator. Balance the crew so that planters can do a good job and keep up with the auger operator(s) and scalpers. Have enough planters to avoid conditions where the soil begins to dry before the planter reaches the hole.

10. Place the seedling against one side of the auger hole and firm the soil around the roots by hand. Note that the standard planting contract requires tree placement near the center of the hole. Modify the specifications to match the project needs. For auger planting, center placement is not desirable for four reasons:

(a) The firm edge of the hole planting is the best reference point for determining the proper planting depth.

(b) Soil tamping is easier and root damage should be less, because of using the back side of the hand instead of the fingers.

(c) The roots have better contact with the intact soil profile.

(d) The root distribution tends to be more three-dimensional; forming an arc (as viewed from above) around the wall of the hole. Root distributions of center-planted trees tend to align along a single plane.

3.62 - Hoe Planting. Hoe planting is generally the least expensive planting method. The method works well on any terrain, but is especially practical on steep terrain or where long walk-ins are required to get to the site. Although it is easier to achieve quality results with the auger, a quality job can result from hoe planting if well-trained crews follow the inspection procedures outlined in Section 3.7. See exhibit 01 for hoe planting techniques.

SEE END OF THIS CHAPTER FOR SECTION 3.62 - EXHIBIT 01

Consider the following when hoe planting:

1. Use the long (17") blade hoe to make a 10" to 12" hole. Lengthen this blade if necessary, by drilling 2 new handle holes in the blade and reattaching the handle.

2. Use the edge or back of the tool for scalping.

3. Break open the hole and place the tree before the soil falls in. Ensure that the planting hole is vertical. Adequate soil firming may require using the hoe both behind, and in front of, the planted seedling. This will prevent air pockets.

3.63 - Bar Planting. The Forest Service does not recommend bar planting for bare-root planting, except on very rocky sites. This method results in poor root distribution. A bar may be easier to use in rocky ground, since it can be wedged in where other tools cannot go. It is more difficult to make a good clean hole with a bar than with a planting hoe. Bare-root seedling placement in the hole may be difficult. Dipping the seedling in a slurry to straighten the roots may help. An air pocket may form at the bottom of the hole. Do not "rock" the bar to close the hole. Instead, insert the bar nearby and pull away to close the bottom of the hole. Exhibit 01 illustrates the technique.

SEE END OF THIS CHAPTER FOR SECTION 3.63 - EXHIBIT 01

The blade should be at least 10-12" long for stock with 9-10" roots. Do not use a bar for scalping. A scalper should work ahead of the planters.

3.64 - Dibble Planting. Use this tool to plant container stock. Consider the following when dibble planting:

1. Dibbles tend to compact the bottom and sides of the hole, which can restrict root growth.

2. Remember to cover the potting medium with at least one inch of soil after planting the plug.

3. Some types of dibbles cannot be used for scalping.

4. Air pockets can easily result from the use of the dibble.

3.65 - Shovel Planting. Spades and shovels have long been used as inspection tools. They are receiving increased use as planting tools. They may be especially suited for larger stock. Recent experience in western Oregon indicates that shovel planting is preferable to hoe or auger planting of large Douglas-fir stock, such as 2-1 or 1-1. Shovel planting may be slower than other hand tools. Spades or shovels can be useful in areas with heavy slash, since they require less space to work in, compared to planting hoes. Exhibit 01 illustrates the technique.

SEE END OF THIS CHAPTER FOR SECTION 3.65 - EXHIBIT 01

3.66 - Machine Planting. Machine planting is common where flat terrain prevails over large areas. They are not well suited to the variable terrain conditions found on many California sites. Most machines form a continuous slit into which seedlings are planted. The slit is then closed behind the plow and the soil firmed by two packing wheels. Where conditions are favorable for their use, average daily production can be quite high, even with a relatively small crew. Of all the methods available, this method is the most restrictive in terms of site conditions.

Consider the following when planning for machine planting:

1. Machine planting does not work well in slash, on rocky ground, or where stumps are frequent. Consider windrowing along the contour in lieu of piling when preparing sites for machine piling.

2. Limit machine planting to slopes of less than about 20%. Although unsafe on steep slopes, machine planting can work well on terraces.

3. Accomplish scalping by using a "V" blade on the front of the tractor.

4. In heavy-textured soils (for example, clay loams or clays) it may be difficult to get the planting shoe to an adequate depth or the slit may not close sufficiently. High soil moisture content adversely affects machine operation on heavy-textured soils.

5. Large tractors may cause excessive wear on planting machines; however, the tractor must be sufficiently large to lift the machine off the ground, over obstacles, and around turns.

6. "L" roots are common, especially if the roots have not been trimmed to the desired lengths, or if the machine moves too fast. Inspections must be made right behind the machine. Some immediate replanting and interplanting will be necessary after the machine goes over rough, uneven ground. Carry flagging to mark these areas.

7. Planting small units can be expensive, because of equipment moving costs. Production rates can average about 5,000 seedlings per day for a crew of 3. To keep the machine supplied with trees may require advance preparation of trays.

8. Safety can be a problem due to slope, rough ground, and windrows. Shield planters from loose sticks and slash. The planting conditions may be dusty if done too long after site prep or the last rain. The planting machine should have a safety switch so that the planter can stop the tractor.

3.7 - INSPECTION. Inspections are essential regardless of the source of the planting crews. The inspection process should be the same regardless of who is doing the planting.

Most contracts require 90% quality to get full payment. They also require immediate suspension if work falls below 80%. These percentages

are recommended, but before using them, carefully examine how the calculation of payment will work. A common method for calculating payment involves multiplying the above ground results by the below ground results. The resultant quality percentage is often less than 95%, even with excellent planters.

3.71 - Training. Designate the COR and inspectors, as well as defining the limits of authority for each, well ahead of the planting project. COR and inspector training sessions presented by the Forest Contracting Section are very important. They teach the basics of paperwork and administrative technique. However, generally they do not teach how to inspect planting effectively. The forest contracting section needs to provide specific planting-related training at the forest and district level in conjunction with inspector training prior to each planting season. Actual experience with planting and inspection is necessary to develop adequate inspector capabilities. Include contract interpretation, tree handling and storage, actual plot inspection, plot location, documentation, and calculation of quality percentage. Have new inspectors work with experienced inspectors until they are capable of independent work.

3.72 - Tools. Inspectors should have access to each of the following items:

1. Tape or pole for measuring plot sizes. Do not use string because it can change length with different tensions or moisture contents.

2. Inspection forms. A field notebook can be used, but transfer the information to the inspection forms on at least a daily basis.

3. Shovel and trowel.

4. Compass (see Sec. 6.13).

5. Pencil.

6. Flagging and marking pen.

7. A copy of the contract.

8. A dial head thermometer. Inspectors must frequently check bag temperatures to test the adequacy of field storage and transportation methods. Check the accuracy of the thermometer periodically.

9. Sling psychrometer.

10. Wind gauge.

11. Clinometer, or similar device to measure slope, and a slope correction table for plot sizes.

12. A "pressure bomb" to monitor seedling moisture stress condition (see Sec. 3.2).

3.73 - Design. Inspections serve several purposes. A primary purpose is to determine the level of payment. Also, inspections can be used to determine the work quality of a particular crew or crew member. Design inspections in keeping with the specific objective. For example, inspections used to determine the payment level must be unbiased samples, for these inspections represent the job or pay item as a whole. Inspections aimed at identifying correcting poor quality work by an individual or particular crew must, of necessity, involve sampling more heavily to ensure the work is brought up to standard. Another example of a "biased" inspection would be to sample a particular sub-item more heavily than others. Do not use the results from these types of inspections as a basis for determining the payment level.

Apply the following guidelines when designing inspections to determine payment:

1. Inspect each pay item separately.

2. Plots should cover at least 1% of the planted area.

3. Confirm completion of planting work with the contractor prior to inspecting the area.

4. Fixed-area plots, arranged on systematic grid from a random start, will generally produce good results if the planting is more or less uniformly spaced. This design assures equal sampling intensity throughout the planted area (regardless of day-to-day production variations), and an unbiased sampling of the entire planting job.

5. The system used to make payment determinations should incorporate a systematic random sample. Locating plots on a fixed grid, with a random starting point, is simple to accomplish.

6. On sites where pacing is difficult, for example, on steep slopes or on sites with obstructions, such as large slash, using a tape may be desirable.

7. Do not flag the locations of plots in unplanted areas, unless they can be inconspicuously marked.

8. Systematic grids are most efficiently installed using two inspectors, particularly when inspecting large planting crews.

For inspecting work for purposes other than payment determination, consider using zig-zag inspections. This system allows one inspector to keep up with the planting crew and check directly behind planters. Zig-zag inspections provide the inspector with an assessment of the quality of the work currently performed by the crew or a particular individual. The system is recommended when starting a new crew to correct mistakes before completing a lot of work. Pay special attention to the lead planters. They typically plant the majority of the seedlings, but become physically separated from the main crew.

3.74 - Timing. Make informal or compliance inspections soon after planting so that planting errors may be corrected as soon as possible. Avoid making inspections more than 1-2 hours behind the planting. At

least one inspector should always be on the unit while crews are planting. Make acceptance inspections as soon as possible, but usually not until completion of substantial portions of the units.

3.75 - General Strategy. Inspection includes taking plots, inspecting tree handling, fire safety compliance, and so forth. Assure that the contractor complies with all contract specifications for storage, loading, and handling. Notify contractor in writing to correct violations. If violations continue, take at least one of the following actions:

1. Notify the contractor's designated representative.

2. Secure all damaged stock, and notify the contractor, in writing, that you will recommend to the CO withholding the value of such stock from payment. Count these trees as "wasted" trees.

3. Request the COR to issue a stop work order.

Charge for damaged ("wasted") trees if the contractor violates either the storage or handling requirements of the contract.

The key to successful planting contract administration is to know the job. Only use inspectors and CORs who have done the work themselves. The inspectors and COR must know the contract in detail before they try to administer it. The COR must know general contracting procedures.

Successful contract accomplishment requires following the contract specifications by both parties. The Government must do everything the contract says it will, so be sure the contract is correct from the start. Follow written inspection procedures exactly. Do not compromise or make deals. If needed, have the CO write a contract Change Order.

If there are questions, refer to the contract. When in doubt, do not speculate on what you think the contract may say. Base your answers on the wording in the contract.

Be sure that the contract fits the prescription and EA. Review the standard contract for applicability to each unit. Do not deviate from the prescription because you "know better". Supplement the contract when necessary.

Use written "instructions to inspectors" covering all aspects of the job. Clarify the inspection specifications by describing the procedure in the written instructions. Train the inspectors in the field. Ensure that all inspectors have the same understanding of the job, and will use uniform procedures and standards.

3.76 - Plot Procedure. Conduct inspections as described in the contract. Meet project objectives by designing, or modifying, the contract. Do not attempt to make up for inadequacies by interpreting the results to favor one party over the other.

The following outlines suggested procedural steps:

1. Locate plot center by stopping at the correct number of paces. Correct your pacing for slope as you walk.

2. Flag or stake the plot center. Write the plot number on flagging. Insert the shovel at the plot center.

3. Hook the tape on the shovel and measure out the correct plot radius. Take plots on a horizontal plane, but correct for slope. Drop a stone from the tape to check the locations of borderline trees. Do not estimate slope or plot radius because small errors in radius measurements affect the plot size significantly. For instance, three inches added to a 1/50th acre plot adds 3% to the plot size.

4. Walk around the plot, holding the tape, counting the 'in' trees and checking the "above ground" specs. A self-winding logger's tape is best as it will automatically stay tight as you move in and out to check individual trees. Count carefully, and try to locate the planting 'grid' so that you can determine where trees should be.

5. 'Above ground' items to check for include all specifications listed in the contract. Specific items to check include (but are not limited to):

(a) Check for correct height. The ground level should be between the root collar and the first live needle, and in no case should roots be on or near the surface. Ground level is the normal plane of the ground. If piled around the stem, brush away extra soil before checking for correct height.

(b) Check soil firmness. Ensure sufficient packing of the soil to eliminate air pockets or excessive settling during the next rain. Hard packing can damage roots. The inspector should not be able to uproot the seedling by gently tugging upward.

(c) Check spot selection. For example, if an unused shady spot is present within the spacing limits, and if the planted spot is not otherwise superior to the unused spot, the tree is incorrectly planted.

(d) Check vertical placement. The contract should give a range, such as, "between vertical and perpendicular to the slope."

(e) Check to ensure size of scalp meets specifications and seedling is near the center of scalp.

(f) Check for spacing. If more than 2 or 3 extra trees are present, it may be because of incorrect spacing. If the contract has a limit on the number of countable trees per plot, count excess trees as wasted.

(g) Check plantable spots. In unplanted areas, determine the number of plantable spots. Try to sink a shovel in the spots most likely to be plantable within the spacing limits for that plot. If gaps exist, look for unplantable spots even if the optimum number of trees are present.

6. Check 'below ground' inspection. If the contract uses a procedure that multiplies the below ground inspection results by the above ground inspection results, dig the 2 (or as otherwise specified) closest trees to the plot center that are satisfactory above ground.

Inspect below ground by carefully digging a hole with a hand trowel beside the tree to the depth of the lowest roots. Then scrape away the dirt until exposing the roots. Consider the tree incorrectly planted if any of the following conditions apply:

(a) Major roots not oriented between vertical and perpendicular to the slope.

(b) The tap root or major lateral roots are "J"d or "L"d.

(c) There is bark, snow, large rocks, dry soil, or other avoidable foreign matter in the hole.

(d) There are air pockets, or loose soil, indicating inadequate soil firming.

(e) Roots damaged, pruned, bunched, or twisted. Be especially alert for pruned roots. Check for a smaller average root length during inspection than you saw in the bundles that morning. This indicates root pruning by an unwatched crew, which is a serious breach of contract.

An alternative way to check for "J" roots is to insert the shovel blade to full depth about 2" from the tree. Be sure that the blade is vertical and to the side of the tree if on a slope. Tip out the shovel full of soil with the tree in place. Brush away the soil to expose the roots. This system is quick and especially useful for an inspector watching the crew. Many trees can be dug quickly and cleanly in this manner. However, this system is not recommended as the sole method for digging trees, because air pockets can go undetected. For this reason, do not use this method for acceptance inspections.

3.76a - Documentation. Documentation for force account and contract planting can utilize the same process. Documentation includes completion of inspection forms, daily diary entries, and the Reforestation Activity Card (Form R5-2400-203). Data collected should also be sufficient to meet the local requirements of the SRS database.

Inspection form data include: forest, district, inspector, contract number or crew (F/A), plot size, unit no., contractor item no., acres, average spacing, maximum trees per plot, plot no., planting spots, unplantable spots, plantable spots, maximum allowable trees, planted trees, wasted trees, satisfactory above ground trees, number of dug trees, and number of satisfactory trees dug. On the back of the form, or on an attached map, draw a sketch of the unit with plot locations.

The daily diaries entries should include: lift date, seed zone, lot and age class, crew name and number working, times worked, inspection results (percentage and main problems) ground condition (site prep and moisture), number of trees planted, unit number, humidity, air temperature, soil temperature, and pressure bomb readings. This documentation stored as

history of the unit for use in evaluating success and failures, and forwarded to your supervisor and the contracting officer to keep them informed. Also, the Labor Relations Board may use daily diaries during wage disputes and other government agencies may use them during investigations and litigation.

3.76b - Correcting Errors. The chief reasons for inspection and careful monitoring are to prevent errors, and if errors do occur, to correct them as soon as possible.

3.76c - Contractor Errors. Encourage the contractor's designated representative to inspect at least the first few plots with you to show the representative the errors you find, particularly if you are having problems.

Do not talk directly to the planter. It may be inferred that you are supervising, and you may end up responsible for poor work and for slowing the work rate. Talk to contractor's designated representative.

Remember that full payment for 90% planting quality means that a few mistakes are acceptable. If you slow a crew down by requiring 95%, you may be held responsible for the extra time.

Advise the contractor's designated representative of the exact standing (for example, 86%, 95%, or other) as often as feasible. Inform the representative and document immediately if inspection falls below full payment level. Inform in writing when percentage falls below minimum acceptable (for example, 80%).

Notify the contractor's designated representative prior to their leaving the area if the planting is not acceptable.

If not raised to an acceptable percentage, and if you have the delegated authority, issue a stop work order for the rest of the day, if necessary.

If the problem appears to be uncorrectable, advise the contractor that you will recommend termination and default to the CO. It is the role of the CO to default a Contractor.

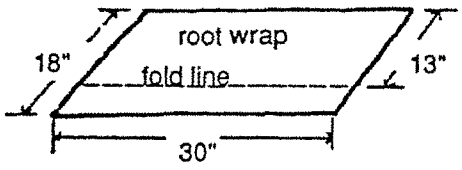
3.76d - Rework. Some contracts allow rework if the inspection score is low. Such contract clauses should always include "the government may allow....". Problems with rework are many. Only permit rework if you have extra suitable planting stock and acceptable planting conditions. Decide how to count the existing bad trees you must reinspect after rework and who will pay for this inspection. Never have the contractor dig up planted trees in order to plant them again. Inspect each unit separately.

3.76e - Force Account Errors. Utilize supervisory skills that encourage the planters to accept the project objectives. Attempt to build crews from employees who will participate voluntarily. Check the condition of the tools. Have a non-planting foreman dig trees behind the crew to maintain good quality planting. Review the specifications. Identify problem planters and retrain if needed. Remove unsatisfactory planters from the project.

3.53 - Exhibit 01

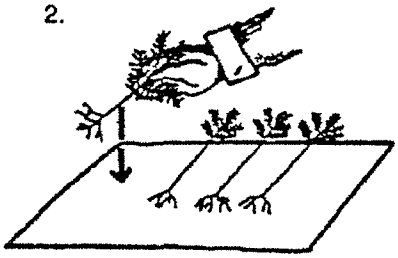
Jelly Roll (Root Wrap) Method

1.



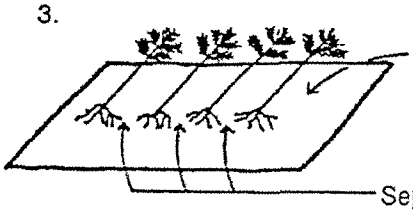
Prepare root wrap as shown.

2.



Arrange trees as shown. Avoid tangling the roots.

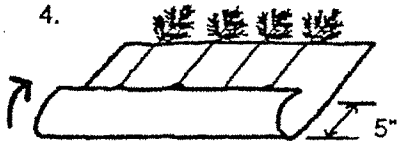
3.



Leave edge of root wrap free of trees.

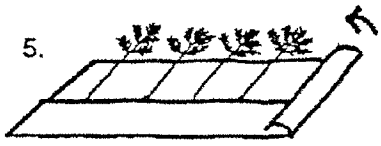
Separate trees to prevent entanglement of roots.

4.



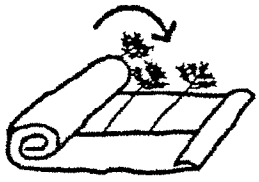
Fold bottom root wrap to keep all sides moist.

5.



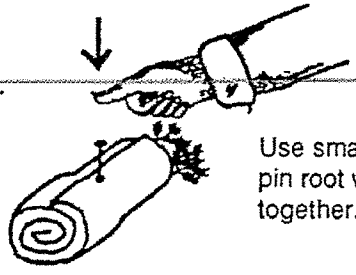
Fold right edge over 1" to help minimize evaporation.

6.



Roll frimly to insure that all roots remain in contact with wet root wrap.

7.



Use small nail to pin root wrap together.

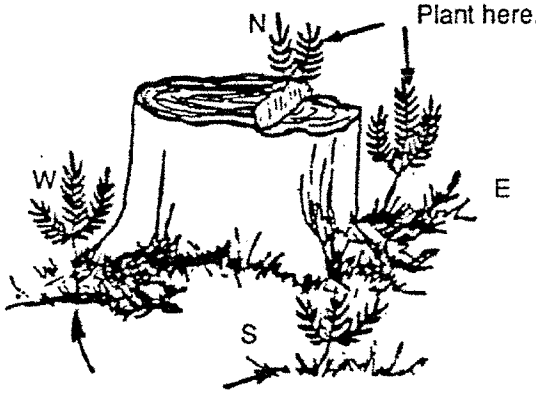
8.

Roll root wrap into bundle. The layers of root wrap act as a wick to hold water at bottom of bag and keep all roots moist.

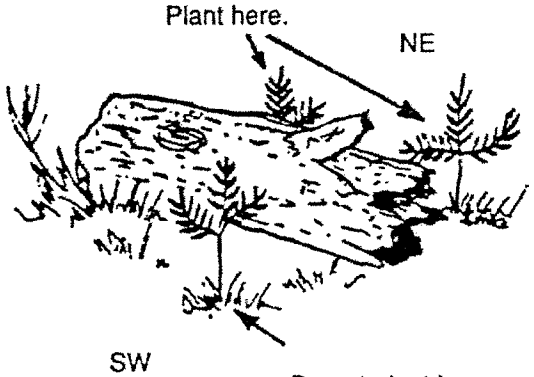
3.54 - Exhibit 01

Use of Shade During Planting

On south to west aspects, plant on the north or east side of logs, stumps, rocks, and other shade-providing material. Seedlings that do not take advantage of these materials are not planted correctly.

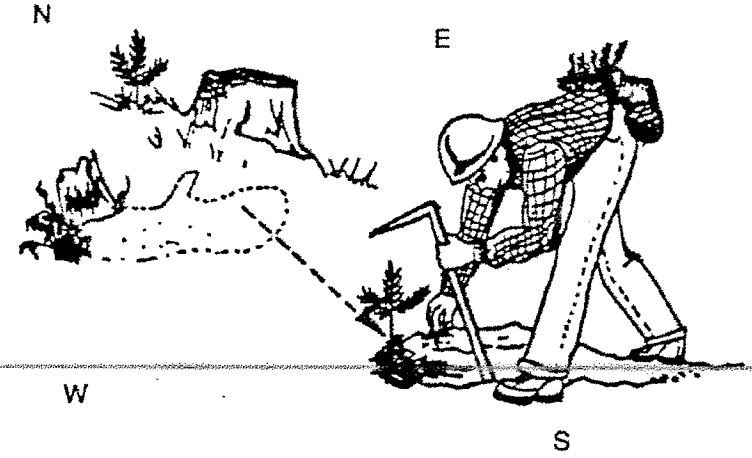


Do not plant here.



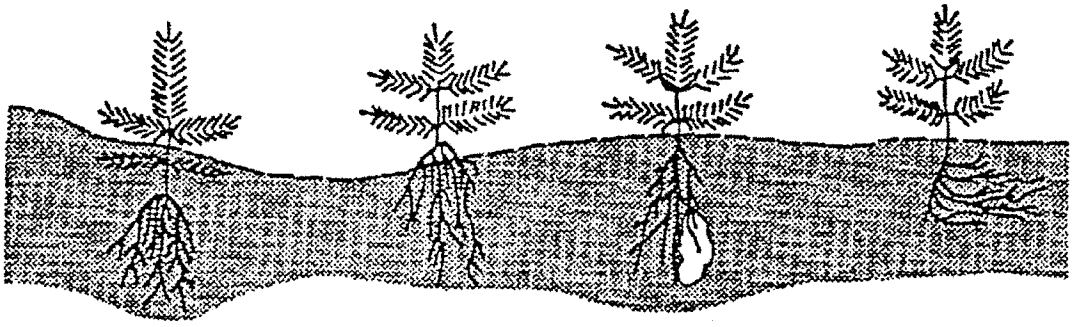
Do not plant here.

Select planting spots that provide shade. Planted trees may often be protected with small, movable materials nearby.



3.55 - Exhibit 01

Unsatisfactory (1-9) and Satisfactory (10) Planting

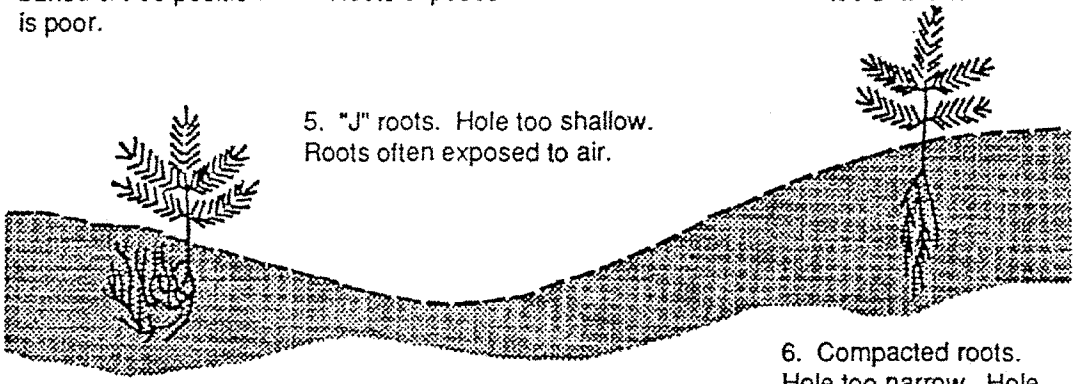


1. Too deep. Needles buried & tree position is poor.

2. Too shallow. Roots exposed.

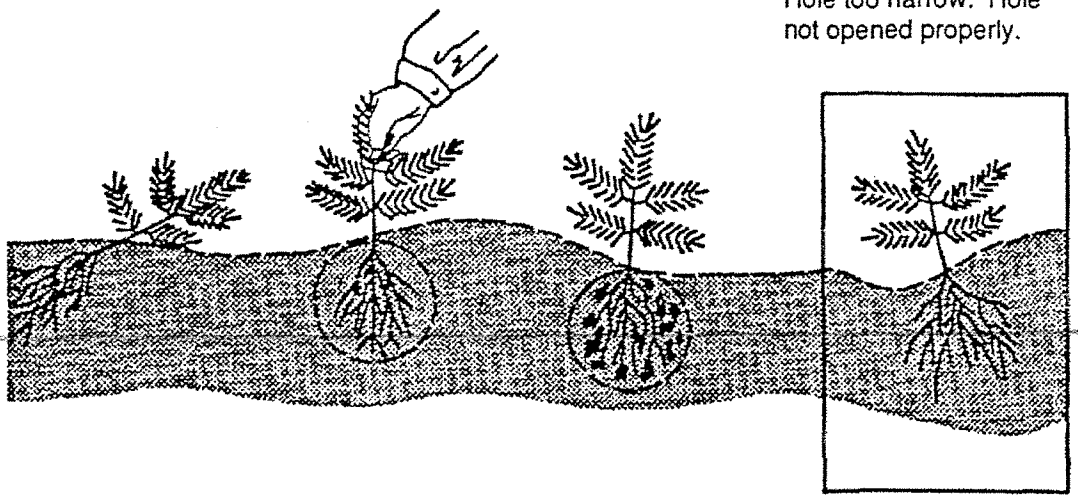
3. Air Pocket.

4. "L" roots. Hole too shallow.



5. "J" roots. Hole too shallow. Roots often exposed to air.

6. Compacted roots. Hole too narrow. Hole not opened properly.



7. Not vertical. Shallow planting. Poor hole alignment.

8. Too loose. Improper tamping after planting.

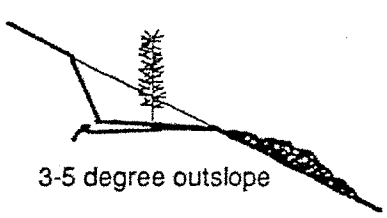
9. Poor planting spot. Roots placed into duff, and woody debris. Not in damp mineral soil.

10. A satisfactorily planted tree. Proper depth and alignment in mineral soil.

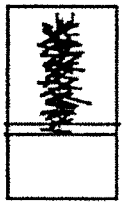
3.55 - Exhibit 02

Planting Spot Preparation by Scalping

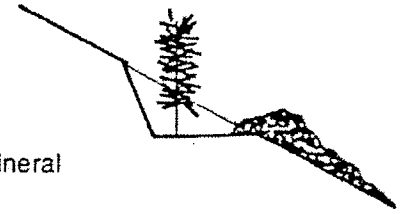
1. Full bench scalp, or terrace, with debris escape.

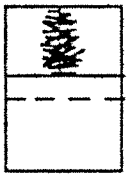


3-5 degree outslope

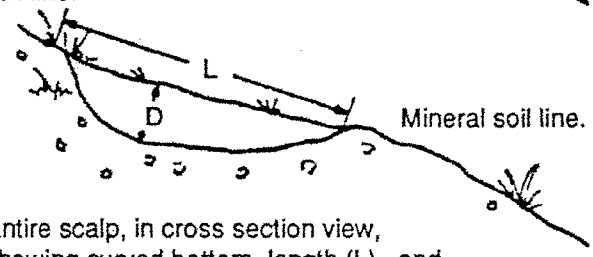


2. Full bench, or terrace, with lip retention.

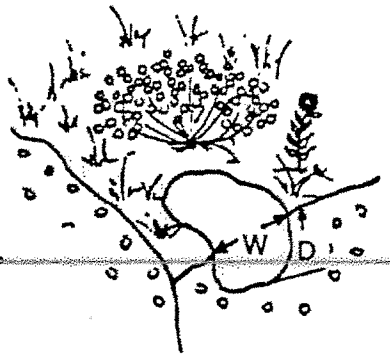




3. Scalp below mineral soil line.



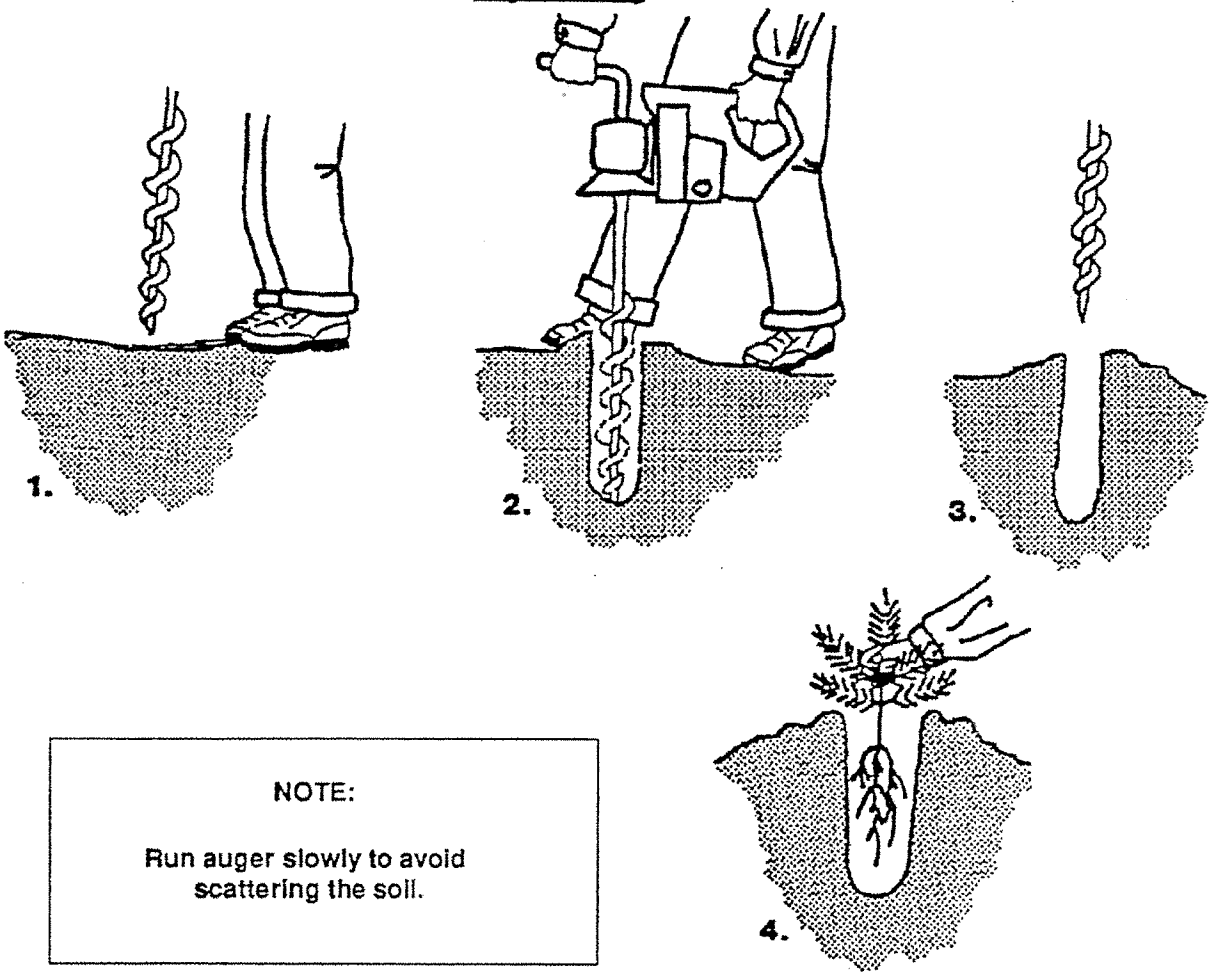
Entire scalp, in cross section view, showing curved bottom, length (L), and depth (D) at point where seed ling should be planted.



Upper half of scalp. Width (W) and depth (D), where seedling should be planted, is indicated.

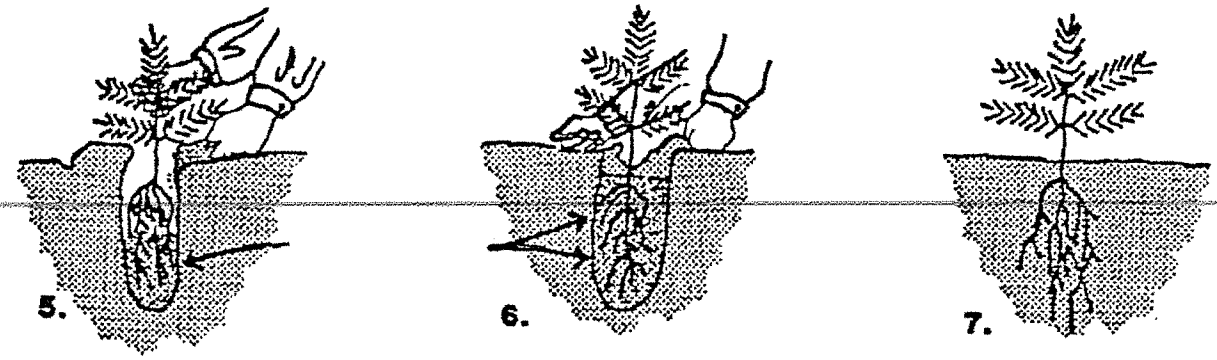
3.61 - Exhibit 01

Auger Planting



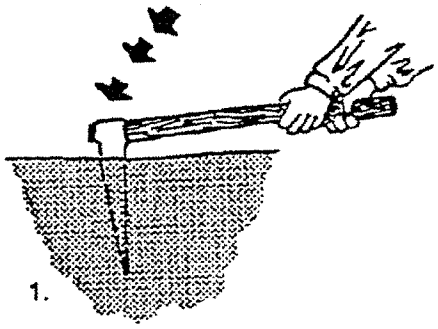
NOTE:

Run auger slowly to avoid scattering the soil.



3.62 - Exhibit 01

Hoe Planting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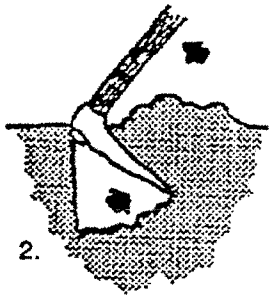
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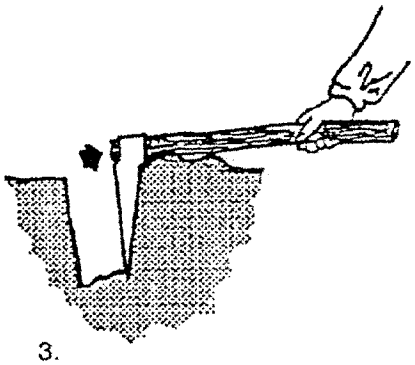
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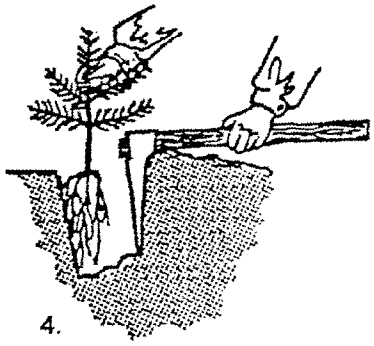
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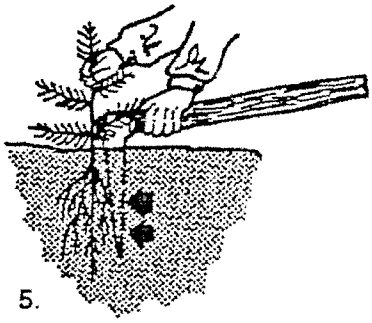
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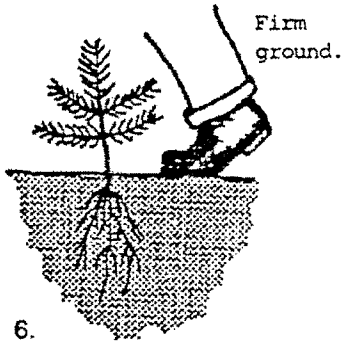

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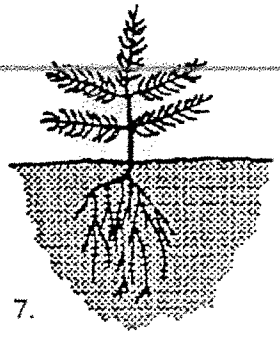
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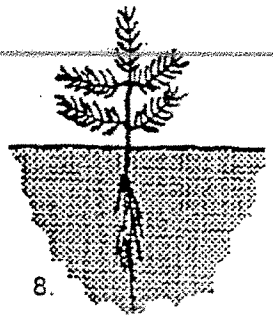
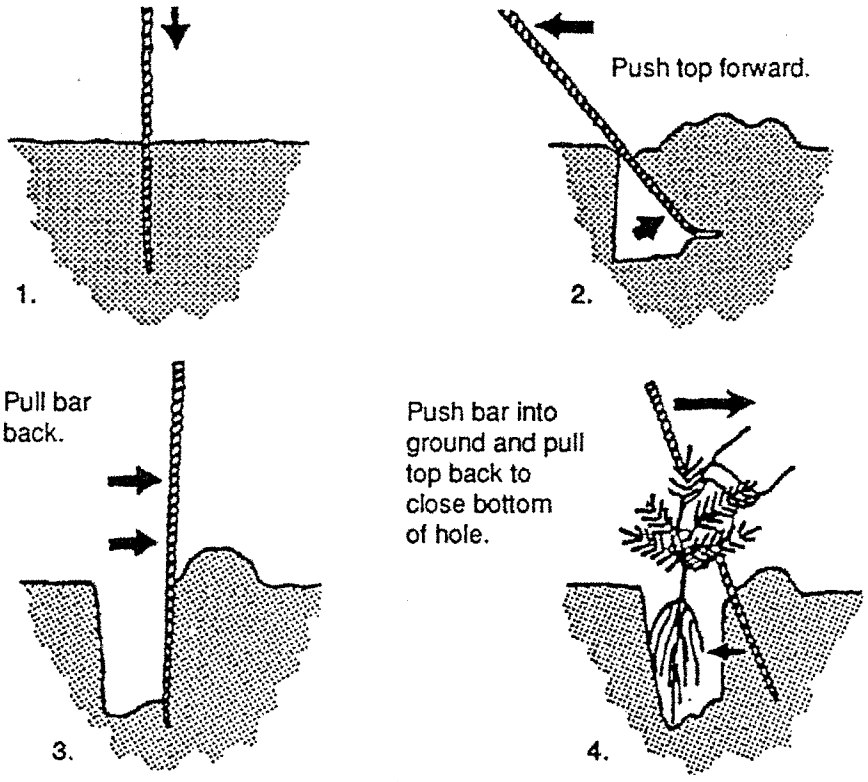

8.

Front View

Side View

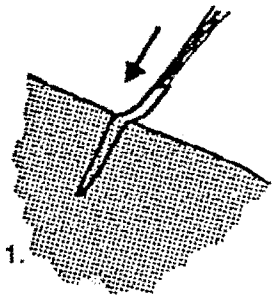
3.63 - Exhibit 01

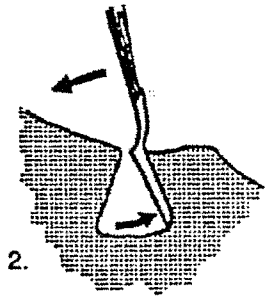
Bar Planting

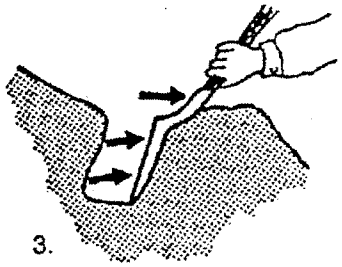


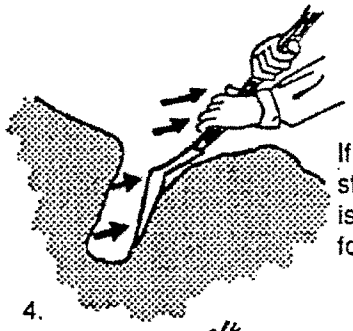
3.65 Exhibit 01

Shovel Planting

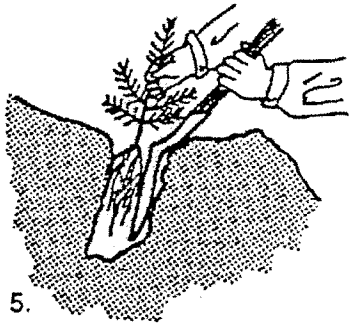


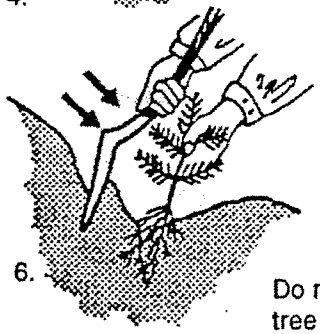




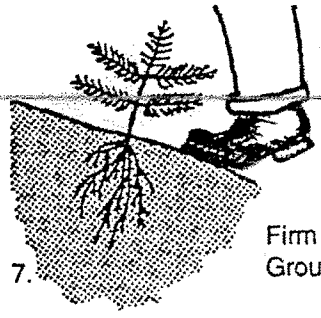


If needed, repeat steps 1-3 until hole is deep enough for seedling roots.

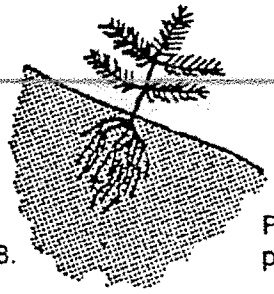




Do not wedge tree against side of hole.



Firm Ground.



Properly planted tree.

FSH 2409.26b - REFORESTATION HANDBOOK

CHAPTER 4 - SURVIVAL AND STOCKING SURVEYS

Contents

4.1 - REFORESTATION REQUIREMENTS AND REPORTS. The National Forest Management Act of 1976 (Sec. 6 (g)(3)(E)) directs that timber will be harvested from lands only where "there is assurance that such lands can be adequately restocked within five years after harvest." 36 CFR 219.27 (C)(3) provides additional clarification: "when trees are cut for timber production objectives, the cuttings shall be made in such a way as to assure that the technology and knowledge exists to adequately restock the lands within 5 years after final harvest." Furthermore, the Act requires that "All national forest lands treated from year to year shall be examined after the first and third growing seasons and certified ... as to stocking rate.... Any lands not certified as satisfactory shall be... scheduled for prompt treatment" Sec. 4 (d)(1). Reforestation exams or surveys are, therefore, necessary to verify meeting the requirement of satisfactory stocking rate.

In Region 5, base certification for adequate restocking on a systematic survey of, at least, a one percent sample of the area. Certification can take place after the third growing season from planting or anytime thereafter that established seedlings meet Regional certification requirements. Do not certify stands being regenerated with the shelterwood method until accomplishment of the overstory removal step.

All commercial species are acceptable as stocking. Include natural seedlings, saplings and pole-sized timber toward meeting stocking requirements, if capable of growth greater than or equal to the planted stock over the projected rotation length.

4.11 - Certification Requirements. Adequate restocking consists of:

1. Meeting a minimum number of established commercial conifer trees per acre (TPA) by forest type and site class.

2. At least 50 percent stocked plots.

3. Stocking well distributed over the area.

Silviculturists shall certify plantations as stocked, when in their professional judgment there is reasonable assurance that the plantation will persist in the expected future under prescribed management practices.

Persistence means that no additional funds will be needed to replant, release for survival, or protect to meet stocking objectives as stated in this section, or as otherwise stated in the prescription for the stand.

Do not consider growth rates. Growth rate objectives are not criteria for certification of adequate restocking.

Examples:

1. If gophers are present or expected to be present in the plantation, and you project that they will reduce the stocking to unacceptable levels, do not certify the stand until controlling the gophers, or you conclude they will no longer reduce stocking.

2. If you have a fully stocked plantation, but you know from experience that it will fail to meet required stocking levels unless you release it, do not certify the plantation. If, however, the plantation will persist without further treatments, certify it.

Do not certify contiguous areas, (generally greater than 5 acres) that are below the minimum stocking level if you can break out that portion of the stand out and manage it separately. Treat areas smaller than 5 acres if you can prepare or replant the site for less than or equal to the normal cost of these activities on the forest.

4.11a - Minimum Acceptable Stocking. The definition of minimum acceptable stocking is that number of well-spaced growing stock trees that will result in full site occupancy, but with a delay of twenty years for the first commercial harvest. Stocking below the minimum indicates the need for replanting, or supplemental planting where feasible. A certified silviculturist can approve alternative stocking levels based on a site-specific prescription.

4.11b - Recommended Stocking. The definition of recommended stocking is that number of well-spaced growing stock trees able to produce an intermediate commercial harvest as early as possible in the life of the stand. Stocking substantially higher or lower than this number may delay the initial intermediate harvest. The RAMPREP model is the basis for determining the time of initial intermediate harvest. The criteria for potential harvest are: dominant height of fifty feet, determined from R-5 site curves; an average stand diameter of at least 13 inches DBH; and a basal area of 90% of normal.

The recommendations given in exhibit 01 have been simplified from those determined in the original analysis, partly to make them easier to use and partly to reflect the limits of precision in the analysis. In general, uniformity of spacing is more important than actual tree numbers and stocking examinations must reflect this.

4.11b - Exhibit 01

Minimum Acceptable Stocking and Recommended Stocking

Forest Type	R-5 Site Class	Minimum TPA	Recommended TPA
Ponderosa & Jeffrey Pine	0 and 1	150	200
	2	125	200
	3	100	150
	4 and 5	75	125
Red/White Fir	All	200	300
Douglas-fir	All	125	225
Mixed Conifer	All	150	200
Other	(Forest Supervisor may establish as needed)		

4.11c - Marginal Stocking. Marginal stocking is stocking less than the recommended level but greater than the minimum acceptable level. Consider an area understocked if the stocking is less than the minimum acceptable level. Map marginal and understocked areas from the plot data. Those areas marginally stocked may not need work if experiencing no further losses, or if you can reasonably expect additional natural regeneration in an acceptable period. Schedule marginally stocked areas for reexamination within two years.

Schedule unstocked or understocked areas, with no reasonable assurance of minimum acceptable stocking within an acceptable time, for replanting. Do this as soon after determining the need for planting as is feasible.

4.12 - Stand. Stand is a community of trees or other growth forms occupying a specific area. The trees are sufficiently uniform in species composition, structure, age, arrangement or conditions to be distinguishable from adjacent stands to form a silvicultural or management unit. The smallest area to delineate as a stand is five acres.

4.13 - Stocking. Stocking is the degree of occupancy of land by trees, measured by basal area and/or number of trees by size and spacing, compared with a stocking standard, such as, basal area and/or number of trees required to fully utilize the growth potential of the land.

4.14 - Established Seedling. Natural seedlings must survive at least two growing seasons to be considered established. Planted seedlings must survive the first three growing seasons to be considered established.

4.15 - Growing Stock Tree. A growing stock tree(s) is a tree of commercial species that contains, or will contain, a merchantable log or product. This excludes rough, rotten or dead trees.

4.16 - Crop Tree. A crop tree(s) is the tallest, fastest growing, healthiest growing stock tree(s) on a specified spacing within a plantation or young stand. The crop tree concept relates to the desired stocking level, therefore the number of trees considered as crop trees per acre should be consistent with the desired number of trees per acre.

4.17 - Reports. The Survival Report for 1st and 3rd year plantings is generated from information contained in the stand record system database. Refer to the Timber Management Control Handbook (R-5 FSH 2409.21e) for additional information. Records used to provide this data need to be in the database prior to January 15 of each year.

Reports summarizing stocking and survival exam data are available through the Data General software program REFEX (Reforestation Examination Program). Refer to the REFEX User's Guide.

4.2 - REFORESTATION SURVEYS. Use the following instructions for reforestation surveys within the constraints outlined:

Walk-through surveys are useful as a fast way to see how a plantation is doing in general. Systematic surveys are for gathering more detailed information used to determine percent survival, stocking, distribution and trees per acre (TPA) by species. These examinations are also useful in identifying animal damage problems or potential significant competition from other vegetation. Retain the results of each survey in the stand record folder.

For systematic surveys, an automated system for collection of stocking and survival information is available. Field data recorder software is available to collect, audit, and transfer data to the Data General system for summarization by REFEX. REFEX, a program that resides on the Data General system, reads data recorder output files or provides for keyboard entry of manually collected data. After data entry and auditing, REFEX summarizes the collected data, provides summary reports, and constructs transfer files that can be used to move data to a Stand Record System (SRS) database.

4.21 - Walk-Through. During the summer following the planting, make several informal walk-through checks. It takes only a few minutes to determine if the seedlings are surviving. If trees start dying as soon as warm weather begins, there was probably something wrong with the stock, handling, or planting. Later losses may be due to gophers, or competition for moisture from grass or brush. If not checked until fall, it is more difficult to determine the cause of losses. You cannot take corrective measures if the cause for failure is unknown.

In subsequent years, schedule at least one annual visit until establishment of the plantation. Visit all portions of the plantation. The examiner should watch for significant damage by deer, porcupine, gophers, other vertebrates, insects, pathogens and significant competition from other plants. Closely examine recently dead trees, above and below ground, for possible causes of death. Report evidence of insect, disease or animal damage on a Forest Pest Detection Report, form R5-3400-1, and forward through the Forest Supervisor to the Regional Forester.

4.22 - Systematic Examination. This procedure is the standard for ascertaining adequacy of regeneration and certifying as to adequacy of stocking required by the National Forest Management Act. As a minimum, make a systematic survey after the end of the first and third growing seasons in order to determine stocked and non-stocked areas, stocking distribution, percent survival of planted seedlings, and TPA by species for both planted and natural.

Complete first year examinations after the first growing season and load records onto the SRS database to include in the first year Plantation Survival Summary Report due January 15th. Similarly, complete third year exams after three growing seasons. Be sure the annual drought period has ended before examination. Include all examinations conducted during the months of July through December in the survival report.

After accomplishing replanting, reschedule the area for a first and third year examination, and do not certify until the third growing season after replanting.

Schedule second year examinations if experiencing stocking failures early due to unusual droughty conditions, animal or other damage causing agents.

The dormant season is the most efficient time to conduct a survey, after the grass and other herbaceous vegetation dies in the fall. Small trees are difficult to see and easily overlooked if examined during the growing season.

While conducting systematic surveys, it is common to collect additional information on site conditions, damage causing agents, competing vegetation and other resource information such as number of snags, down logs and large residual trees. The reforestation survey forms provide a standardized approach for collecting much of this optional information.

When examining a plantation, take along to the site stand history information for verification. If the site conditions appear to be different than the history indicates, note the discrepancy. Make corrections to the stand history when confirming errors by personal knowledge of the history, service contract documents or other reliable stand record information.

4.22a - Systematic Survey Procedures. Data collection via the field data recorder software is facilitated by fill-in-the-blank screen entry or use of forms R5-2400-231 or R5-2400-234. Manually collected data can be entered, via the keyboard, into REFEX for summarization and database updating. Detailed data collection instructions follow in the expansion of this section.

4.22b - Sample Plot Design. Install a systematic grid of survey plots, with a random start, over the plantation. Collect data for 2 nested plots at each plot location. One plot is a variable radius plot used to calculate percent stocking. The other plot is a fixed radius plot used to calculate trees per acre and tree measurements.

Determine the radius of the variable radius plot by measuring and recording the distance from the plot center to the nearest growing stock tree. Compare this measurement to the minimum stocked plot radius to determine whether or not the plot is stocked to the minimum standard. For example, if the minimum stocking standard for a site is 125 trees per acre (stocked plot radius equals 10.5 feet), then any plot with a growing stock tree within 10.5 feet of the plot center is stocked.

With this technique, comparing measured distance to the nearest tree with the radius of other plot sizes also allows you to determine the stocking at other levels, such as the percentage of a plantation stocked to the recommended level or greater.

The radius of the fixed radius plot should be greater than the average distance between trees. The total area sampled with the fixed radius plot will be a minimum of one percent of the plantation area. If selecting a 1/100th acre plot size, then require at least one plot per acre. If selecting a smaller plot size, then increase the number of plots per acre.

Obtain a measure of stocking distribution by plotting the locations of stocked, non-stocked and non-stockable plots. Map plot locations in order to identify where stocking is inadequate. A high degree of mapping accuracy is not necessary. Indicate on the map stocked "S", non-stocked "N" and non-stockable "X" plots so that you can locate potential rework areas.

4.22c - Non-Stockable Spot. A non-stockable spot is an area within a stand where you cannot plant conifer seedlings or expect them to survive or grow (as on rock outcrops, exceptionally poor soils with extremely high gravel content, high water table or hard pan, compacted landings, existing roads, water, wet meadow) and the area is too small or narrow to map and track as a non-commercial or non-forest opening.

4.23 - Reforestation Survey Plot Record. The following instructions refer to fields on the Reforestation Survey Plot Record, form R5-2400-231, exhibit 01 and the alternate Reforestation Survey Worksheet, form R5-2400-232, exhibit 02. These instructions also provide the information needed to accomplish field data recorder or REFEX input.

SEE END OF THIS CHAPTER FOR SECTION 4.23 - EXHIBITS 01 AND 02

In these instructions for gathering and recording seedling information, "Size" refers to number of characters. "Type" refers to alphabetic or numeric character.

Note: All coding of numeric fields is right-justified while all alphanumeric fields are left-justified. Therefore, leading zeros are not needed.

4.23a - Stand Identification. Fields 1-6 describe the stand and must be recorded.

Field 1, Record Type (required)

Size = 1; type = alpha

Pre-recorded: R

Field 2, Administrative National Forest (required)

Size = 2; type = numeric

Code	Forest	Code	Forest
01	Angeles	10	Six Rivers
02	Cleveland	11	Plumas
03	Eldorado	12	San Bernardino
04	Inyo	13	Sequoia
05	Klamath	14	Shasta-Trinity
06	Lassen	15	Sierra
07	Los Padres	16	Stanislaus
08	Mendocino	17	Tahoe
09	Modoc	18	Trinity
		19	Lake Tahoe Basin

Field 3, Planning Unit (required)

Size = 1; type = numeric

All forests are coded 1, with the following exceptions:

Forest	Planning Unit	Code
Klamath	Westside	1
	Eastside	2

Field 4, District (required)

Size = 2; type = numeric

Use two-digit Ranger District code.

Field 5, Compartment (required)

Size = 3; type = numeric

Use codes from National Forest or Ranger District compartment map.

Field 6, Stand Number (required)

Size = 1-4; type = numeric

Record the stand number.

4.23b - Survey Objectives. Fields 7-13 identify the date, the year of survey and the stocking objectives. These fields are required.

Field 7, Date (required)

Size = 4; type = numeric

Record the date by using a four-digit code. Show the month in the first two digits and the year in the third and fourth digits, using the last two numbers of the year in which the stand was surveyed, (MMYY):

Code	Month	Code	Year
01	January	87	1987
02	February	88	1988
03	March	89	1989
06	June	90	1990
10	October	91	1991
11	November	92	1992
12	December	01	2001

Examples: For August 1988; code 0888
December 2001; code 1201

Field 8, Year Survey (required)

Size = 1; type = numeric

Record the year of the survey for the plantation exam. The growing seasons since the last planting determines the year survey. Valid codes are 1 through 9.

Field 9, Regional Type (required)

Size = 1; type = alpha

Record the regional forest type for the area. Regional types consist of single species or combinations of species having a predominance of crown area. In the case of a plantation, this refers to the forest type for the general location.

Code	Regional Type
A	Alpine
B	Brewer spruce
C	Coulter pine
D	Douglas-fir
E	Eastside pine
F	Eastside mixed conifer
G	Giant sequoia
H	Hardwoods
J	Jeffrey pine
L	Lodgepole pine
M	Mixed conifer
N	Pinyon-Juniper
O	Port-Orford-cedar
P	Ponderosa pine
R	Red fir
S	Redwood
T	Mountain hemlock
W	White fir

Field 10, R-5 Site Class (required)

Size = 1; type = alphanumeric

Record the Site Class for the stand. Use information from the previous stand if available from the stand record. If not available, measure trees from surrounding stands of similar site conditions. If such trees are unavailable, estimate the site from aspect, elevation, soil, and vegetation and record in Field 10.

Requirements of a Site Tree to apply Dunning's Site Classification:

1. Tree position must be predominant or dominant and have grown freely all its life.

2. Tree must be at least 50 years old.

3. Species must be Douglas-fir, white fir, red fir, ponderosa pine, Jeffrey pine, or sugar pine. (Species = 1,11,12,13,31 or 32)

4. Tree must be of a suitable form class. A rough cull does not qualify as a site tree.

5. A tree must have its original top.

Site classes represented by height and age are shown below.

4.23b - Exhibit 01

REGION 5 SITE CLASSES
(HEIGHT BY AGE AND SITE CLASS CODE)

Site Class (Field 10)

Age	0	1	2	3	4	5
40	95	81	66	49	43	35
50	106	90	75	56	49	39
60	115	98	82	63	53	43
70	122	105	88	68	58	45
80	129	111	93	73	61	48
90	135	116	98	77	64	50
100	140	121	102	81	67	54
110	145	125	106	84	70	54
120	149	129	109	87	72	55
130	153	133	112	90	74	57
140	157	136	115	93	76	58
150	160	139	118	95	78	60
160	163	142	120	98	80	61
170	166	144	123	100	81	62
180	169	147	125	102	83	63
190	172	149	127	104	84	64
200	175	152	129	106	86	65
220	179	156	133	109	88	67
240	184	160	136	112	90	68
260	188	163	139	115	93	70
280	191	166	142	117	95	71
300	195	169	145	120	96	73
320	198	172	147	122	98	74
340	201	175	150	124	100	75
360	204	177	152	126	101	76
380	206	180	154	128	103	77
400	209	182	156	130	104	78

Note: Based on ponderosa pine, Jeffrey pine, sugar pine, Douglas-fir, red fir, and white fir. Age is in years. Total height is in feet of average dominant and predominant trees with tree age of at least 50 years. Adapted from Dunning's site index curves for height at 300 years. Bulletin #28 Forest Research Notes 12/1/42 rerun 11/58.

Field 11, Plot Factor (required)

Size = 1-3; type = numeric

Record the Plot Factor for the selected fixed radius plot size. This will usually be a 1/100-acre plot size. The following are examples:

4.23b - Exhibit 02

Code		Plot Size (acre)	Plot Radius (feet)
25	1/40	(.025)	18.6
20	1/50	(.020)	16.7
10	1/100	(.010)	11.8
5	1/200	(.005)	8.3
2	1/500	(.002)	5.3
1	1/1000	(.001)	3.7

Field 12, Minimum Acceptable Stocking TPA (required)

Size = 3; type = numeric

For the Regional Type and R-5 Site Class of the sampled stand record the minimum acceptable stocking trees per acre from the following table:

Forest Type	R-5 Site Class	Minimum Acceptable Stocking (Trees/Acre)
Ponderosa & Jeffrey Pine	0 and 1	150
	2	125
	3	100
	4 and 5	75
Red & White Fir	All	200
Douglas-fir	All	125
Mixed Conifer	All	150
Other	(Forest Supervisor may establish as needed)	

When the stand prescription has a different specified minimum stocking level than the standard for the forest type and site class, record the prescribed minimum trees per acre in Field 12.

Field 13, Stocked Plot Radius (required)

Size = 3; type = numeric

Record the radius corresponding to the minimum acceptable stocking recorded in Field 12. Do not record the decimal point, since it is assumed that the far right column is 1/10 of a foot.

TPA	Radius (ft)
75	13.6
100	11.8
125	10.5
150	9.6
200	8.3

4.23c - Site Characteristics. Fields 14 to 17 are optional. They are needed however, if the tree information is to be used as input into growth and yield models such as the Stand Prognosis Model.

Field 14, Aspect

Size = 1; type = numeric

Code	Azimuth (degrees)	Aspect
1	337.6 - 22.5	North
2	22.6 - 67.5	Northeast
3	67.6 - 112.5	East
4	112.6 - 157.5	Southeast
5	157.6 - 202.5	South
6	202.6 - 247.5	Southwest
7	247.6 - 292.5	West
8	292.6 - 337.5	Northwest
9	---	Level

Field 15, Slope

Size = 1; type = numeric

Code	Slope Angle (%)	Code	Slope Angle (%)
0	$\leq$ 5	5	46 - 55
1	6 - 15	6	56 - 65
2	16 - 25	7	66 - 75
3	26 - 35	8	76 - 85
4	36 - 45	9	$\geq$ 86

Field 16, Elevation

Size = 2; type = numeric

Plot elevation is in 100's of feet. Example 10 = 1000 ft., 35 = 3500 ft.

Field 17, Ecological Type

Size = 6; type = alphanumeric

Record the code for ecological type if available.

4.23d - Plot Stocking and Seedling Information. Fields 18-33 describe the Seedling Record.

4.23e - Required Information. Fields 18-23 are required to be filled for all plots for determining stocking condition and trees per acre by species.

Field 18, Plot Number (required)

Size = 1-2; type = numeric

Record the plot number for each plot taken in the stand. Repeat the plot number for each line of information for a particular plot.

Field 19, Distance to the Nearest Tree (required on first line of each plot. Not allowed on subsequent lines.)

Size = 1-3; type = numeric

Measure and record in tenths of a foot, the horizontal distance from the plot center to the nearest commercial tree that meets the criteria for a growing stock tree (see section 4.15). There is no need to measure out more than 16.7 feet in search of a tree ~~or to record a distance~~, since this is the plot radius for 50 trees per acre, well below any minimum stocking standard* The growing stock tree can be a residual tree that can be merged with the planted trees over the rotation; natural seedlings, saplings or pole size trees.

Field 20, Stocking Code (required on the first line of each plot. Not allowed on subsequent lines.)

Size = 1; type = alpha

Compare the Distance to the Nearest Tree, Field 19, with the Stocked Plot Radius, Field 13.

If the distance to the tree is less than or equal to the stocked plot radius, the plot is stocked; record code "S".

~~If the distance is greater than the stocked plot radius, the plot is not stocked; record code "N".~~

If the area within the minimum stocked plot radius is a non-stockable spot, record an "X".

*(Record a distance of 999 in this case)

Field 21, Commercial Trees (required)

Size = 1-2; type = numeric

Record the code for the commercial species found on the plot for each line entry for each plot. The Forest Supervisor designates commercial species for each National Forest.

COMMERCIAL TREES

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
69	011	SF	Abies amabilis	Pacific silver fir
69	014	SLF	Abies bracteata	Santa Lucia fir
31	015	WF	Abies concolor	White fir
33	017	GF	Abies grandis	Grand fir
69	019	AF	Abies lasiocarpa	Subalpine fir
32	020	RF	Abies magnifica	California red fir
69	021	SRF	Abies magnifica shastensis	Shasta red fir
69	022	NF	Abies procera	Noble fir
53	041	PO	Chamaecyparis lawsoniana	Port Orford-cedar
69	042	AC	Chamaecyparis nootkatensis	Alaska cedar
64	050	CUP	Cupressus sp.	Cypress
63	064		Juniperus occidentalis	Western juniper
51	081	IC	Calocedrus decurrens	Incense cedar
46	092	BS	Picea breweriana	Brewer spruce
41	093	ES	Picea engelmannii	Engelmann spruce
69	098	SS	Picea sitchensis	Sitka spruce
26	101	WBP	Pinus albicaulis	Whitebark pine
34	102	BCP	Pinus longaeva (aristata?)	Bristlecone pine
24	103	KP	Pinus attenuata	Knobcone pine
30	104	FP	Pinus balfouriana	Foxtail pine
15	108	LP	Pinus contorta	Lodgepole pine
21	109	CP	Pinus coulteri	Coulter pine
29	113	PF	Pinus flexilis flexilis	Limber pine
12	116	JP	Pinus jeffreyi	Jeffrey pine
13	117	SP	Pinus lambertiana	Sugar pine
14	119	WP	Pinus monticola	W. white pine
25	120	BP	Pinus muricata	Bishop pine
11	122	PP	Pinus ponderosa	Ponderosa pine
69	124	MP	Pinus radiata	Monterey pine
23	127	DP	Pinus sabiniana	Digger pine
27	140		Pinus monophylla	Singleleaf pinon
69	180	PIAT2		Knobcone x Monterey pine
69	181	PIAT2		Jeffrey x coulter pine
69		PIWA	Pinus washoensis	Washoe pine
02	201	BDF	Pseudotsuga macrocarpa	Bigcone Douglas-fir
01	202	DF	Pseudotsuga menziesii	Douglas-fir
05	211	RW	Sequoia sempervirens	Redwood
06	212	GS	Sequoiadendron giganteum	Giant sequoia
62	231	PY	Taxus brevifolia	Pacific yew
54	242	RC	Thuja plicata	Western redcedar
48	263	WH	Tsuga heterophylla	Western hemlock
47	264	MH	Tsuga mertensiana	Mountain hemlock

Field 22, Number of Trees Planted (required)

Size = 1-2; Type = numeric

On each plot, for each commercial conifer species, record the number of live planted tree seedlings found within the fixed plot area.

Field 23, Number of Natural Trees (required)

Size = 1-2; type = numeric

On each plot, for each commercial species, record the number of natural trees found within the fixed plot area. Count up to ten trees per commercial species that are taller than six (6) inches and have survived for at least two growing seasons. Record only trees free of damage. Count only trees that are likely to grow to a merchantable size.

4.23f - Optional Information. Fields 24 through 33 are optional, however the information is useful for monitoring plantation growth, vigor and pest damage. These instructions must be supplemented as to the crop trees to be measured (see Section 4.16).

When taking measurements on advanced reproduction of seedlings or saplings, keep measurements separate for planted and natural trees.

Field 24, Optional

Size = 1-2; type = alphanumeric

This field is reserved for local use.

Field 25, Crop Tree Height

Size = 1-3; type = numeric

Record the height, in tenths of a foot, for the crop tree or average crop trees found on the plot.

Field 26, Leader Length

Size = 1-2; type = numeric

Record the previous year's height growth, in tenths of a foot, for the crop tree or average crop trees by species found on the plot.

Field 27, Caliper

Size = 1-2; type = numeric

Record the stem caliper in tenths of an inch, for the crop tree or average crop trees by species found on the plot. Measure the stem caliper at one inch from the ground level.

Field 28, Vigor Rating

Size = 1; type = numeric

Determine the crop tree or average crop tree vigor rating by species found on the plot. This is a proxy for crown ratio and is a rating of 1 through 9. Record for all live trees. For near-dead trees, use code 1.

Seedling vigor can relate to fullness of crown, color, leader length, number of lateral buds and needle retention. The vigor rating is relative to trees of the same species on similar sites. Forest Silviculturists should develop guidelines for consistency. One possibility is the use of a photo guide for each major species.

Field 29, Damage / Death

Size = 3; type = alpha

Use this field to record by species, type of crop tree damage, cause of damage and severity of damage or reason for death. Code damage type txx, damaging agent xax, and severity xxs by species.

An example of a damage code is ADH, Animals:Deer:Heavy damage.

Definitions of severity ratings follow:

"Light" damage is present, but will have little effect on growth or survival.

"Moderate" damage will cause one or two years growth loss of the crop trees, but will not affect survival.

"Heavy" damage, unless controlled, will prevent the crop trees from becoming a commercial product or eventually result in their death.

Damage / Death Codes

Code	Damage Factor
A__	ANIMALS
C_	Cattle
D_	Deer Browse
H_	Horse
G_	Pocket Gopher
S_	Ground Squirrel
M_	Mountain Beaver
P_	Porcupine
R_	Rabbits
W_	Sheep
V_	Meadow Vole
O_	Other
P__	PHYSICAL/CHEMICAL
B_	Burial
D_	Drought
F_	Frost damage
H_	Herbicide
J_	J Root
P_	Planting error
S_	Snow breakage
W_	Wind desiccation
O_	Other
I__	INSECT
A_	Aphid
B_	Bark Beetles
C_	Caterpillar/Moths
G_	Grasshopper
M_	Spider mites
S_	Scale
W_	Weevil
X_	Cut worms
O_	Other
R__	ROOT ROT
A_	Armillaria
B_	Black Stain
F_	Fomes Annosus
P_	Phytophthora
R_	Rhizina
O_	Other
F__	FOLIAGE DISEASES
B_	White Pine Blister Rust
C_	Cankers
G_	Gall Rust
M_	Dwarf Mistletoe
N_	Needle Cast
O_	Other

Code	Severity
__L	Light Damage
__M	Moderate Damage
__H	Heavy Damage

Field 30, Micro-site Condition

Size = 2; type = alpha

Record the site condition of the plot. Use this information when considering replanting or analyzing regeneration problems.

Code	Site Condition	Code	Plantabilty
A_	Ash (burnt piles)	_X	Not plantable
D_	Dead standing brush	_D	Difficult planting
G_	Gravelly	_M	Moderate planting
H_	Hardpan	_E	Easy planting
L_	Landing		
M_	Meadow		
N_	No obstructions		
O_	Rock outcrop		
R_	Road bed or skid road (compacted)		
S_	Slash / stump		
V_	Competing vegetation		
W_	Wet / swampy		

Field 31, Plot Aspect

Size = 1; type = numeric

Record the aspect at the plot location. See Field 14 for codes.

Field 32, Plot Slope

Size = 1; type = numeric

Record the slope at the plot location. See Field 15 for codes.

Field 33, Optional

Size = 1-2; type = alphanumeric

This field is reserved for local use.

4.3 - REFORESTATION SURVEY. Summary reports can be generated by REFEX. Alternately, if selecting manual data collection and summarization, use the R-5 Reforestation Survey Summary form, R5-2400-233, exhibit 01, to summarize information on stocking and trees per acre by species. The seedling status summary provides information needed for the Survival Report and to determine if the stand meets the certification standards. REFEX can provide transfer files that are used to update the SRS database, providing the records needed to meet survival reporting requirements.

SEE END OF THIS CHAPTER FOR SECTION 4.3 - EXHIBIT 01

A sketch map, depicting the sample plot locations and stocked plot distribution, may be created on the back of the data collection form. Likewise, other maps of the area, especially a traverse map, may be used for this purpose and filed with the stand records.

REFEX is available to summarize collected data. Alternately, data could be summarized as in the following sections:

4.31 - Percent Stocking. Calculate the percent stocking for the Minimum Acceptable Stocking TPA (Field 12) by:

1. The sum of the stocked plots (S stocking code Field 20),

2. Divided by the sum of all stockable plots (S and N stocking codes Field 20).

Percent Stocking = # stocked plots / # stockable plots

4.32 - TPA by Species. Calculate the number of trees per acre by species by summing the total of trees of a given species, divided by the total number of plots and multiplied by the plot expansion factor.

Calculate the planted and natural trees separately for each species.

4.33 - Percent Survival. To calculate percent survival, divide the total number of live planted trees from the 1st or 3rd year regeneration survey, by the total number of trees initially planted in the area.

Base the estimate of the number of trees initially planted on the planting inspection results. An estimate of the number of trees delivered and planted on the site can also be used, but may not be as reliable.

When replanting takes place, use net surviving planted trees before replanting, plus the number of additional planted trees, as the basis for the calculation.

Do not calculate percent survival based on dead trees found on the plots. Dead trees are not a reliable method since they can be missed due to clipping by rodents, buried in other vegetation or ravel, or be completely missing due to gophers. By the third year, finding dead planted trees is highly variable due to decomposition.

If expecting survival to be a problem in a particular plantation and the causes of mortality are unknown or need specific identification, consider beginning an administrative study using a large sample of individually staked trees. By this method, you can track dead or missing trees over time and determine causes of death.

4.34 - Average Trees per Acre. To calculate the average number of trees per acre:

1. Sum the total number of trees for all line entries.

2. Divide by the total number of plots taken.

3. Multiply by the plot expansion factor.

A list of plot expansion factors follows:

Plot Size Acre	Plot Expansion Factor TPA	Plot Factor Code (Field 11)
1/2	2	500
1/4	4	250
1/5	5	200
1/10	10	100
1/40	40	25
1/100	100	10
1/1000	1000	1

Note: The non-stockable plots are included in the total number of plots taken, since the areas are included in the total acreages of the area sampled. If the area(s) of non-stockable ground are large enough to be of concern, map them out and exclude from the plantation acreage, if possible. If the non-stockable ground is scattered throughout the stand, the stand management prescription should take this into account by recommending a lower stocking objective.

If desired, the statistics can be calculated for average TPA. The following instructions provide for determining the ± standard error for one standard deviation (68 percent confidence limits). The use of a standard statistical package for hand calculators, such as the Hewlett Packard, is useful for completing the following calculations.

Where:

X = sample value, in this case the number of trees per plot 1 to n

M = mean, average trees per plot

n = Total number of plots in the sample

$\bar{\geq}$ = sum of the values

s = standard deviation

SE = standard error

PEF = plot expansion factor or 1 divided by sample plot size

First caculate the mean or average TPA:

$$M = \frac{\bar{\geq} X}{n}$$

Next calculate the standard deviation of the mean:

$$s = \sqrt{\frac{\bar{\geq} X^2 - \frac{(\bar{\geq} X)^2}{n}}{n - 1}}$$

And last the mean standard error:

$$SE = \sqrt{\frac{s^2}{n}}$$

To calculate the confidence interval in TPA:

$$M\,(PEF) \pm SE\,(PEF)$$

Here is an example: Fifteen 1/100 acre plots were sampled for a tally of seedlings in a 15 acre plantation. Their trees per plot are listed with the sums of number trees and number of trees squared.

Plot#	#Trees/Plot	$(\#Trees/Plot)^2$
1	3	9
2	1	1
3	0	0
4	2	4
5	5	25
6	4	16
7	1	1
8	0	0
9	3	9
10	6	36
11	2	4
12	1	1
13	2	4
14	5	25
15	3	9
n = 15	$\sum x = 38$	$\sum x^2 = 144$

The mean:

$$M = 38 / 15 = 2.53 \text{ trees/plot}$$

The standard deviation:

$$s = \sqrt{\frac{144 - \frac{(38)^2}{15}}{15 - 1}} = \sqrt{\frac{47.7}{14}} = 1.85$$

The standard error:

$$SE = \sqrt{\frac{(1.85)^2}{15}} = .48$$

The confidence interval:

$$TPA \pm SE = 2.53(100) + .48(100)$$

$$= 253 \text{ TPA} \pm 48$$

4.4 - OPTIONAL VEGETATION DATA. Collection of competing vegetation data is optional. This data is usually collected as an indicator of release or site prep needs. The field data recorder software provides for collection and auditing of this information. Alternately, use the Vegetation Survey Plot Record, form R5-2400-234 to record the information. As with the Reforestation Survey, REFEX is designed to provide data summarization and to generate SRS transfer files used in updating the S2K database.

Collect detailed vegetation data:

1. When a walk through will not provide sufficient information to determine the need for treatment.

2. To facilitate comparison and ranking of stands for treatment.

3. For comparison of pretreatment and post treatment stand conditions.

Use a 1/100-acre plot size for vegetation cover and species occurrence. When tallying brush seedlings, use a 1/1000-acre plot. Other plot sizes can also be used.

When plots are nested for measuring different vegetation attributes, do not count the same vegetation in more than one of the plots, so the plot data will be additive.

When conducting surveys that do not specifically record planted or natural seedlings as crop trees, use the "C" record type for conifers.

When measuring hardwood clump sprouts, treat hardwoods as tree-form (record type H) if the stems are greater than 1" at DBH. Otherwise, treat hardwoods as brush or shrub form (record type B).

Since vegetation information collection can vary from one project to another, prepare supplemental instructions specifying how to gather and record the data on the Vegetation Survey Plot Record.

4.41 - Vegetation Survey Plot Record. The use of the field data recorder provides for the collection of data items described in the following sections. Alternately, the Vegetation Survey Plot Record, form R5-2400-234, exhibit 01, can be used for recording competing vegetation attributes.

SEE END OF THIS CHAPTER FOR SECTION 4.41 - EXHIBIT 01

In these instructions for gathering and recording vegetation information, "Size" refers to number of characters. "Type" refers to alphabetic or numeric character.

Note: All coding of numeric fields is right-justified while all alphanumeric fields are left-justified. Therefore, leading zeros are not needed.

4.42 - Stand Identification. Fields 1 to 8 are required.

When collecting vegetation data for survival and stocking surveys, complete Fields 1-6 to reference the Vegetation Survey Plot Record (form R5-2400-234) to the Reforestation Survey Plot Record (form R5-2400-231).

When collecting vegetation data for forest inventory, complete Fields 1-5, and use Field 7 to reference the cluster plot number on the Cluster Plot Record, form R5-2400-207.

Field 1, Record Type

Size = 1; type = alpha

Pre-recorded: V

Field 2, National Forest

Size = 2; type = numeric

Use standard codes.

Field 3, Planning Unit

Size = 1; type = numeric

Use standard codes.

Field 4, Ranger District

Size = 2; type = numeric

Use standard codes.

Field 5, Compartment

Size = 3; type = numeric

Use codes from National Forest or Ranger District compartment map.

Field 6, Stand Number

Size = 1-4; type = numeric

Record the stand number. When used in conjunction with the Reforestation Survey Plot Record or stand exams, omit the Cluster Plot Number by use of a dash "-" in Field 7.

Field 7, Cluster Plot Number

Size = 1-3; type = numeric

When using this form in conjunction with a forest inventory, record the cluster plot number corresponding with the Cluster Plot Record. Omit the stand number by use of a dash "-" in Field 6.

Field 8, Date

Size = 4; type = numeric

Record up to a four-digit code to show the month by the first two digits, followed by code showing the year in which the stand was surveyed, (MMYY).

4.42a - Site Characteristics. Fields 9 to 12 are optional.

Field 9, Aspect

Size = 1; type = numeric

Use standard codes.

Field 10, Slope

Size = 1; type = numeric

Use standard codes.

Field 11, Elevation

Size = 2; type = numeric

Plot elevation is in 100's of feet. Example 10 = 1000 ft.,
35 = 3500 ft.

Field 12, Ecological Type

Size = 6; type = alphanumeric

Record the code for ecological type, if available.

4.42b - Vegetation Information. Use Fields 13 to 21 to record various vegetation attributes.

Field 13, Vegetation Record Type

Size = 1; type = alpha

Show the type of record taken for each line entry.

Code	Record Type
C	- Commercial Tree
H	- Noncommercial Tree
B	- Brush
G	- Grass / Forb
X	- No vegetation present

Field 14, Plot/Point Number

Size = 1-2; type = numeric

For reforestation surveys and stand exams, record the plot number corresponding to the sample locations. Plot numbers must be unique for each stand examined, however a plot can have many records of different record types and nested plot sizes.

For forest inventories using cluster plots, record the corresponding point of the cluster plot.

Field 15, Plot Factor

Size = 1-3; type = numeric

Record the plot size code for "C", "H", "B", and "G" records. See 4.23b - exhibit 02 for examples of Fixed Plot Codes.

Field 16, Species

Size = 4-5; type = alphanumeric

Record the species code for the commercial tree, noncommercial tree, brush or grass/forb being measured. Usually, list only the most prevalent 2 or 3 species for each record type.

Use the codes found in the Electronic Data Processing Codes for California Wildland Plants; Merton J. Reed, W. Robert Powell, and Bur S. Bal, U.S. Forest Service Research Note PSW - N20, 1963.

This section includes a list of the most common species found in the Region. Forest Supervisors may supplement this section to include a list for their specific areas.

COMMERCIAL TREES

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
34	011	SF	Abies amabilis	Pacific silver fir
69	014	SLF	Abies bracteata	Santa Lucia fir
31	015	WF	Abies concolor	White fir
33	017	GF	Abies grandis	Grand fir
69	019	AF	Abies lasiocarpa	Subalpine fir
32	020	RF	Abies magnifica	California red fir
69	021	SRF	Abies magnifica shastensis	Shasta red fir
69	022	NF	Abies procera	Noble fir
53	041	PO	Chamaecyparis lawsoniana	Port Orford-cedar
69	042	AC	Chamaecyparis nootkatensis	Alaska cedar
64	050	CUP	Cupressus sp.	Cypress
63	064		Juniperus occidentalis	Western juniper
51	081	IC	Calocedrus decurrens	Incense cedar
46	092	BS	Picea breweriana	Brewer spruce
41	093	ES	Picea engelmannii	Engelmann spruce
69	098	SS	Picea sitchensis	Sitka spruce
26	101	WBP	Pinus albicaulis	Whitebark pine
34	102	BCP	Pinus longaeva (aristata?)	Bristlecone pine
24	103	KP	Pinus attenuata	Knobcone pine
30	104	FP	Pinus balfouriana	Foxtail pine
15	108	LP	Pinus contorta	Lodgepole pine
21	109	CP	Pinus coulteri	Coulter pine
29	113	PF	Pinus flexilis flexilis	Limber pine
12	116	JP	Pinus jeffreyi	Jeffrey pine
13	117	SP	Pinus lambertiana	Sugar pine
14	119	WP	Pinus monticola	W. white pine
25	120	BP	Pinus muricata	Bishop pine
11	122	PP	Pinus ponderosa	Ponderosa pine
69	124	MP	Pinus radiata	Monterey pine
23	127	DP	Pinus sabiniana	Digger pine
27	140		Pinus monophylla	Singleleaf pinon
69	180	PIAT2		Knobcone x Monterey pine
69	181	PIAT2		Jeffrey x coulter pine
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01	202	DF	Pseudotsuga menziesii	Douglas-fir
05	211	RW	Sequoia sempervirens	Redwood
06	212	GS	Sequoiadendron giganteum	Giant sequoia
62	231	PY	Taxus brevifolia	Pacific yew
54	242	RC	Thuja plicata	Western redcedar
48	263	WH	Tsuga heterophylla	Western hemlock
47	264	MH	Tsuga mertensiana	Mountain hemlock

251 CA Torreya

133 Pinyon Pine
Pinus Edulis

060 Juniper Sp.

073 Western Larch

69 Other Softwood

660 Hop'o Sp.
732 CA Sycamore
740 Cottonwood sp.
760 Poplar sp.
920 Willow sp.

500 Hawthorn
510 Eucalyptus
376 Birch

NONCOMMERCIAL TREES

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
76	312	ACMA	Acer macrophyllum	Bigleaf maple
		AECA	Aesculus californica	Calif. Buckeye
		ALRH	Alnus rhombifolia	White alder
71	351	ALRU	Alnus rubra	Red alder
		ALOR	Alnus oregona	Red alder
~~76~~		~~ARME2~~	~~Arctostaphyllos mewukka~~	~~Indian manzanita~~ BRUSH
94	361	ARME3	Arbutus menziesii	Madrone
93	431	CACH2	Castanopsis chrysophylla	Golden chinquapin
95	492	CONU2	Cornus nuttallii	Pacific dogwood
72	542	FRA10	Fraxinus sp.	Ash
87	631	LIDE2	Lithocarpus densiflora	Tanoak
73	746	POTR3	Populus tremuloides	Quaking aspen
75	747	POTR4	Populus trichocarpa	Black cottonwood
80 ~~88~~	800	QUE2	Quercus sp.	
82	801	QUAG	Quercus agrifolia	Calif. or coast live oak
84	805	QUCH2	Quercus chrysolepis	Canyon live oak
88	807	QUDO	Quercus douglasii	Blue oak
86	815	QUGA2	Quercus garryana	Oregon white oak
81	818	QUKE	Quercus kelloggii	California black oak
83	821	QULO	Quercus lobata	California white oak
89 ~~88~~	841	QUMO	Quercus morehus	Oracle Oak
92 ~~88~~		~~QUSA~~	~~Quercus sadleriana~~	~~Sadler oak~~ BRUSH
97 ~~88~~		~~QUVA~~	~~Quercus vaccinifolia~~	~~Huckleberry oak~~ BRUSH
85	839	QUWI	Quercus wislizenii	Interior live oak
61	952	TOCA	Torreya californica	California nutmeg
91	981	UMCA	Umbellularia californica	California laurel
72		~~PLRA~~	~~Platanus racemosa~~	~~Sycamore~~
96	748	PLRA	Western Sycamore	

NONCOMMERCIAL BRUSH

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
		ACCI	Acer circinatum	Vine maple
		ACGL	Acer glabrum	Dwarf (Rocky Mt.) maple
		ADFA	Adenostoma fasiculatum	Chamise
		AME	Amelanchier sp.	Serviceberry
		ARC5	Arctostaphylos sp.	Manzanita
		ARMA4	Arctostaphylos mariposa	Mariposa manzanita
		ARME2	Arctostaphylos mewukka	Indian manzanita
		ARNE2	Arctostaphylos nevadensis	Pinemat manzanita
		ARPA9	Arctostaphylos patula	Greenleaf manzanita
		ARVI3	Arctostaphylos viscida	Whiteleaf manzanita
		ART5	Artemesia sp.	(woody shrub form)
		ARTR	Artemesia tridentata	Big sage
		BAPIC	Baccharis pilularis consanguinea	Coyote brush
		BENE1	Berberis nervosa	Dwarf Oregongrape
		BEPI2	Berberis piperiana	Piper's Oregongrape
		BERE	Berberis repens	Creeping Oregongrape
		BER2	Berberis sp.	Oregongrape
		CASE3	Castanopsis sempervirens	Bush chinquapin
		CECO2	Ceanothus cordulatus	Whitethorn
		CECU2	Ceanothus cuneatus	Buckbrush

BRUSH - Continued

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
		CEIN3	Ceanothus integerrimus	Deerbrush
		CEPR	Ceanothus prostratus	Squaw carpet
		CESA2	Ceanothus sanguineus	Redstem
		CETO	Ceanothus tomentosus	Wollyleaf ceanothus
		CEVE3	Ceanothus velutinus	Snowbrush
		CEOC	Cercis occidentalis	Redbud
		CER8	Cercocarpus sp.	Mtn. mahogany
		CEBE2	Cercocarpus betuloides	Western Mtn. mahogany
		CELE3	Cercocarpus ledifolius	Curlleaf Mtn. mahogany
		CHA7	Chamaebatia sp.	
		CHFO2	Chamaebatia foliolosa	Bearclover
		CHR9	Chrysothamus sp.	Rabbitbrush
		CIVU	Cirsium vulgare	Bull thistle
		COCOC	Corylus cornuta californica	California hazel
		COST3	Cornus stolonifera	Dogwood
		DERI	Dendromecon rigida	Tree poppy
		ERCA6	Eriodictyon californicum	Yerba santa
		GAFR	Garrya fremontii	Silktassel
		GASH	Gaultheria shallon	Salal
		HAAR	Haplopappus arborescens	Golden fleece
		HEAR2	Heteromeles arbutifolia	Toyon
		HODI	Holodiscus discolor	Oceanspray
		LUP4	Lupinus sp.	semiwoody perennial
		LUP5	Lupinus sp.	wooody shrub
		PRU2	Prunus sp.	
		PREM	Prunus emarginata	Bitter cherry
		PRVID	Prunus virginiana demissa	Chokecherry
		PUR	Purshia sp.	
	971	PUTR	Purshia tridentata	Bitterbrush
		RHCA2	Rhamnus californica	Calif. coffeeberry
		RHDI	Rhus diversiloba	Poison oak
		RHMA	Rhododendron macrophyllum	Pacific rhododendron
		RHOC	Rhododendron occidentale	Western azalea
		RIB	Ribes sp.	Ribes
		RINE	Ribes nevadense	Sierra currant
		RIRO	Ribes roezlii	Sierra gooseberry
		ROCA1	Rosa california	California wild rose
		ROS	Rosa sp.	
		ROGY	Rosa gymnocarpa	Bald hip rose
		RUB2	Rubus sp.	(woody shrubs)
		RULE	Rubus leucodermis	Blackcap
		RUPA2	Rubus parviflorus	Thimbleberry
		RUUR	Rubus ursinus	California blackberry
		SACA4	Sambucus cerulea	Blue elderberry
		SALI1	Salix sp.	Willow
		SYM3	Symphoricarpos sp.	Snowberry
		TOCA	Torreya californica	California nutmeg (woody and shrub-like)
		US		unknown brush
		VAC2	Vaccinium sp.	Huckleberry
		VAOC2	Vaccinium occidentale	Western blueberry
		VAOV	Vaccinium ovatum	Evergreen huckleberry

BRUSH - Continued

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
		VAPA	Vaccinium parvifolium	Red huckleberry
		VIC1	Vicia sp.	Vetch
		VICA3	Vitis californica	California grape

GRASS / FORB

R-5 Code	TMIS Code	Alpha Code	Scientific Name	Common Name
		AGR1	Agropyron sp.	Wheat grass
		ANT4	Antennaria sp.	Pussytoes
		BRTE	Bromus tectorum	Cheatgrass
		CIR2	Cirsium sp.	annual/biennial thistle
		CIR3	Cirsium sp.	perennial thistle
		CICA1	Cirsium californicum	Purple thistle
		CIVU	Cirsium vulgare	Bull thistle
		DAC1	Dactylis sp.	Orchard grass
		EPAN	Epilobium angustifolium	Fireweed
		FEID	Festuca idahoensis	Idaho fescue
		FRCA1	Fragaria californica	Wood strawberry
		JUN2	Juncus sp.	Wire grass
		LOPE1	Lolium perenne	Perennial rye
		LUP1	Lupinus sp.	herb. annual/biennial
		LUP2	Lupinus sp.	herbaceous perennial
		LUP3	Lupinus sp.	herbaceous, longevity unknown
		POMU1	Polystichum munitum	Sword fern
		PTAQL	Pteridium aquilinum langinosum	Bracken fern
		PTE1	Pteridium sp.	(perennial)
		UCAN		unknown composites (annual)
		UCWS		unknown composites
		UF		unknown forbs
		UG		unknown grasses
		UGP		unknown perennial grass
		UGA		unknown annual grass
		UGUF		unknown grasses/forbs
		VETH	Verbascum thapsus	Common mullen
		WYE	Wyethia sp.	Mule-ears

ROCK AND BARE GROUND

		ROCK		Rock
		BARE		Bare Ground

Field 17, Percent Cover

Size = 1-2; type = numeric

Record the percent cover for each species on the plot.

Since cover is used here as a proxy for site occupancy, the total cover for conifers, hardwoods and brush species cannot exceed 100 percent.

Values for ground cover can equal an additional 100 percent.

Field 18, Height

Size = 1-2; type = numeric

Record average height to the nearest foot. Do not record height for the grass/forb record type.

Field 19, Number of Hardwood Clumps or Brush Seedlings

Size = 1-2; type = numeric

For noncommercial tree record types, record the number of sprouting clumps found on the plot (usually 1/100 acre).

For brush record types where seedling information is needed, record the number of brush seedlings found on the plot (usually 1/1000 acre) by species. The number of brush seedling information is useful in predicting future competition. Collect it when the brush plants are small and contribute little cover.

Note: When tallying the number of brush seedlings, do not record percent cover on the line entry.

Field 20, Width of Hardwood Clumps

Size = 1-2; type = numeric

When taking hardwood sprout clump information, record the average sprout clump width to the nearest foot. Measure a clump at the widest part of the crown, then measure the width at right angle and average the two measurements.

Field 21, Age

Size = 1-2; type = numeric

Record the age of the hardwood sprouts or brush species found on the plot. Use the plantation history to make the best estimate of age.

Field 22, Optional

Size = 1-2; type = alphanumeric

Reserved for local use. Some suggested uses are vegetation layer or shrub origin (seedling or sprout). Write in the vegetation attribute above the field number and describe the specifications for measure in supplemental instructions.

4.5 - VEGETATION SURVEY. The vegetation information can be summarized in various ways, depending on its intended use. REFEX is able to summarize this information. Alternately, there is space on the Reforestation Survey Summary form, R5-2400-233, under competing vegetation, for recording the vegetation summaries. Some of the most useful information are; cover of brush or grass, volume of brush, number of hardwood clump sprouts per acre and major competing species. This information can be used for determining present and future release treatment needs and options available for control. Other uses might be to provide site specific information for use in determining if replanting can be successful, or use in environmental documents.

4.23 - Exhibit 01

USDA - FOREST SERVICE — R5-TIMBER MANAGEMENT

REFORESTATION SURVEY PLOT RECORD

Crew: SRASO & WARRINGTON

Instructions: MEASURE CROP TREE HEIGHT, LEADER LENGTH & VIGOR

STAND ID. | SURVEY OBJECTIVES | SITE CHARACTERISTIC

1. RECORD TYPE	2. NATIONAL FOREST	3. PLANNING UNIT	4. RANGER DISTRICT	5. COMPARTMENT NUMBER	6. STAND NUMBER	7. DATE	8. YR. SURVEY	9. REG. TYPE	10. SITE CLASS	11. PLOT FACTOR	12. MINIMUM STOCKING (TPA)	13. STOCKED PLOT RADIUS 1/10 ft.	14. ASPECT	15. SLOPE	16. ELEVATION 100 ft.	17. ECOLOGICAL TYPE
R	XX	X	XX	XXX	XXXX	MMYY	X	X	X	XXX	XXX	XXX	X	X	XX	XXXXXX
R	03	1	03	315	0075	0987	3	M	2	10	150	96	2	3	34	—

SEEDLING RECORD

18. PLOT NUMBER	19. DISTANCE TO NEAREST TREE 1/10 ft	20. STOCKING CODE	21. SPECIES	22. NUMBER OF PLANTED TREES	23. NUMBER OF NATURAL TREES	24. OPTIONAL	25. CROP TREE HEIGHT 1/10 ft	26. LEADER LENGTH 1/10 ft	27. CALIPER 1/10 inch	28. VIGOR RATING	29. DAMAGE/ DEATH	30. MICRO-SITE CONDITION	31. PLOT ASPECT	32. PLOT SLOPE	33. OPTIONAL	COMMENTS
XX	XXX	X	XX	XX	XX	XX	XXX	XX	XX	X	XXX	XX	X	X	XX	
01	43	S	11	1			31	15		7						
01			31		2											
02	70	S	11	1			27	13		5						
03	120	N										SD				UNPAINTED PLT.
04	53	S	11	1			42	14		8						
04			31		1											
05	21	S	11	2			40	12		6						
05			51		1											
05			21		2											
06	15	S	11	3			15	6		3	WM					
06			31		1											
07	101	N	11	1								SD				
08	—	X										OX				ROCKY
09	45	S	11	3			35	12		7						
10	21	S	11	4			51	19		9						
10			13		2											
11	56	S	11	2			43	12		5						
12	87	S	11	1			21	0		3	WM					
13	24	S	11	2			36	14		5						
14	76	S	11	2			42	13		7						
14			01		3											
15	62	S	11	2			47	15		7						
15			31		1											

R5-2400-231 (7/87)

4.23 - Exhibit 02

USDA - FOREST SERVICE — R5-TIMBER MANAGEMENT

REFORESTATION SURVEY WORKSHEET

Crew: SRAGO & WARRINGTON

Instructions: MEASURE CROP TREE HEIGHT, LEADER LENGTH & VIGOR

STAND ID. | SURVEY OBJECTIVES | SITE CHARACTERISTIC

1. RECORD TYPE	2. NATIONAL FOREST	3. PLANNING UNIT	4. RANGER DISTRICT	5. COMPARTMENT NUMBER	6. STAND NUMBER	7. DATE	8. YR. SURVEY	9. MGT. TYPE	10. SITE CLASS	11. PLOT FACTOR	12. MINIMUM STOCKING (TPA)	13. STOCKED PLOT RADIUS 1/10 ft.	14. ASPECT	15. SLOPE	16. ELEVATION 100 ft.	17. ECOLOGICAL TYPE
R	XX	X	XX	XXX	XXXX	MMYY	X	X	X	XXX	XXX	XXX	X	X	XX	XXXXXX
R	03	1	03	315	0075	0987	3	M	2	10	150	96	2	3	34	—

SEEDLING RECORD

18. PLOT NUMBER	19. DISTANCE TO NEAREST TREE 1/10 ft	20. STOCKING CODE	21. SPECIES 22. # PLANTED TREES 23. # NATURAL TREES — SPECIES CODE 11 P	11 N	01 P	01 N	51 P	51 N	31 P	31 N	13 P	13 N	24. TOTAL TREES	25. CROP TREE HEIGHT 1/10 ft	26. LEADER LENGTH 1/10 ft	27. CALIPER 1/10 inch	28. VIGOR RATING	29. DAMAGE/ DEATH	30. MICRO-SITE CONDITION	31. PLOT ASPECT	32. PLOT SLOPE	33. OPTIONAL
XX	XXX	X	P	N	P	N	P	N	P	N	P	N	XX	XXX	XX	XX	X	XXX	XX	X	X	XX
01	43	S	1							2			3	31	15		7					
02	70	S	1										1	27	12		5					
03	120	N											0						SD			
04	52	S	1							1			2	42	14		8					
05	21	S	2				1			2			5	40	12		6					
06	15	S	3							1			4	15	6		3	WM				
07	101	N	1										1						SD			
08	—	X									1		0						OX			
09	45	S	3										3	35	12		7					
10	21	S	4								2		6	51	19		9					
11	56	S	2										2	43	12		5					
12	87	S	1										1	21	0		3	WM				
13	24	S	2										2	36	14		5					
14	76	S	2		3								5	42	13		7					
15	62	S	2							1			3	47	15		7					
TOTAL			25		3		1		7		2		38									

R5-2400-232 (7/87)

USDA - FOREST SERVICE — R5 - TIMBER MANAGEMENT

REFORESTATION SURVEY SUMMARY

NF 03 RD 02 COMP 315 STAND 0075 ACTIVITY 4342 YR.SURVEY 3 CY 87 CM 09 ACRES 15 REVIEWER RTW

SEEDLING STATUS

STOCKING PERCENT = 86 %

(P) = Planted TPA
(%) = Survival
(N) = Natural TPA

MAJOR SP.	PP			WF			DF		
	P	%	N	P	%	N	P	%	N
	167	84				47			20

AVG. TPA (P) 167 + (N) 86 = TOTAL 253 ± 48

Seedling Condition: GOOD OVERALL GROWTH, 4' TALL BRUSH COMPETITION BECOMING A PROBLEM SOME BROWSE DAMAGE FROM SHEEP ON PINE

ACTIONS NEEDED

PLANNED STAND ACTIVITIES:

Certify (4311): Year 3 Acres 15 Initials RTW
Re-examine(413___): Year ___ for _____ Reason
Replant(411___): Year ___ Acres ___ Species ___ ___ TPA ___
Site Prep.(4117___): Year ___ Acres ___ Method ___ ___
Animal Dmg Cntrl(4___): Year ___ Acres ___ Method ___
Release(4151): Year 4 Acres 15 Method ___ Chem ___
PCThin(415___): Year ___ Acres ___ TPA ___ Spacing ___ ft

COMPETING VEGETATION

Aggregation # 1
Layer # 2

HARDWOOD SPECIES	% COVER	HT.	# /ACRE	CLMP WD	AGE
QUKE	—	4	7	3	3
QUWI	—	3	20	2	3
TOTAL					

Layer # 2

BRUSH SPECIES	% COVER	HT.	#/ACRE	VOL ft3	
ARPA9	15	3		19,620	
CEIN3	5	3		6,540	
CHFO2	—				
TOTAL	20	3		26,000	

Layer # 3

GRASS/FORB SP.	% COVER	
UGA	7	
UGP	3	
TOTAL	10	

RESIDUAL TREES

Aggregation # ___

SOFTWOODS: Layer # ___
MAJOR SPECIES ___, ___, ___

	BA/A	TPA	HT	CUFT	BDFT
Saplings (1.0-4.9"DBH)					
Poles (5.0-8.9"DBH)					
Sm. Sawtimber (9.0-20.9"DBH)					
Lg. Sawtimber (21.0"DBH +)					
TOTAL					

HARDWOODS: Layer # ___
MAJOR SPECIES ___, ___, ___

	BA/A	TPA	HT	CUFT	BDFT
Saplings (1.0-4.9"DBH)					
Poles (5.0-8.9"DBH)					
Sm. Sawtimber (9.0-20.9"DBH)					
Lg. Sawtimber (21.0"DBH +)					
TOTAL					

SNAGS
(≥ 16" DBH & 20ft Ht.) Soft _____ TPA
Hard _____ TPA

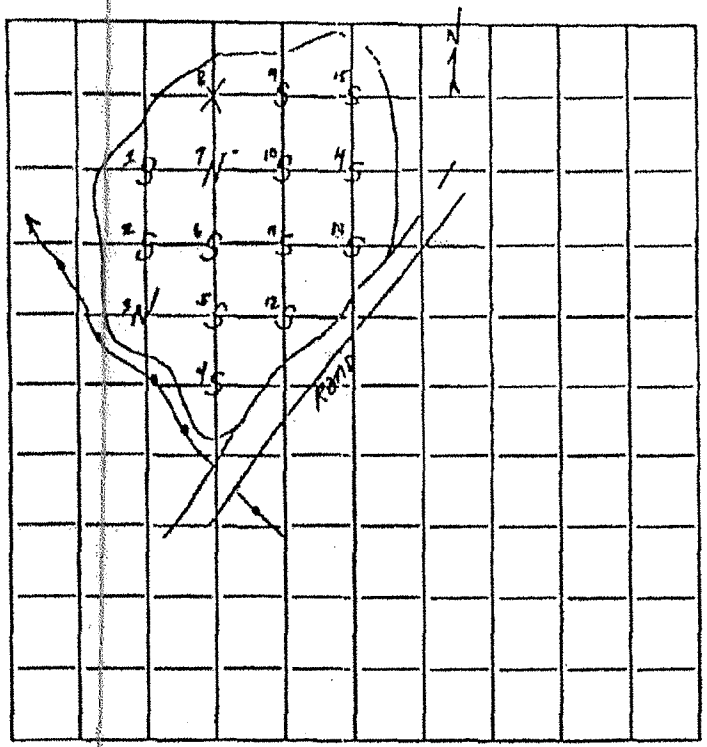
R5-2400-233 (7/87)

4.3 - Exhibit 01

REFORESTATION SURVEY

NF 03 RD 03 COMP 315 STAND 0075 YR. SURVEY 3 DATE 0987 CREW MJS / CJW

MAP



The space above is provided for sketching the plantation boundary. Each line intersect represents a possible plot location. Show stocked (S), non-stocked (N) and non-stockable (X) plot locations to display stocking distribution.

CALCULATIONS

PERCENT STOCKING:

$$\frac{\text{\# (S) plots}}{\text{\# (S) + (N) plots}} = \frac{12}{14} = 86\%$$

PERCENT SURVIVAL MAJOR SPECIES:

Species PP

$$\frac{\text{Planted TPA Surviving}}{\text{Initial TPA Planted}} = \frac{167}{200} = 84\%$$

Species _____

$$\frac{\text{Planted TPA Surviving}}{\text{Initial TPA Planted}} = \frac{\quad}{\quad} = \_\_\_\_$$

Species _____

$$\frac{\text{Planted TPA Surviving}}{\text{Initial TPA Planted}} = \frac{\quad}{\quad} = \_\_\_\_$$

4.41 - Exhibit 01

USDA - FOREST SERVICE — R5-TIMBER MANAGEMENT

VEGETATION SURVEY PLOT RECORD

Crew: GRAGO & WARRINGTON | Instructions: COLLECT BRUSH COVER & HEIGHT HARDWOOD STRATA & GROUND COVER

PLOT / STAND ID. | DATE | SITE CHARACTERISTICS

1. RECORD TYPE	2. NATIONAL FOREST	3. PLANNING UNIT	4. RANGER DISTRICT	5. COMPARTMENT NUMBER	6. STAND NUMBER	7. CLUSTER PLOT NUMBER	8. DATE	9. ASPECT	10. SLOPE	11. ELEVATION 100 ft.	12. ECOLOGICAL TYPE
V	XX	X	XX	XXX	XXXX	XXX	MM YY	X	X	XX	XXXXX
V	03	1	03	315	0075	—	0987	2	3	34	—

VEGETATION RECORD

13. RECORD TYPE	14. PLOT/POINT NUMBER	15. PLOT FACTOR	16. SPECIES CODE	17. % COVER	18. HEIGHT ft.	19. # RDM CLUMPS / BRUSH SEEDLINGS	20. WIDTH OF RDM CLUMPS ft.	21. AGE	22. OPTIONAL	COMMENTS
X	XX	XXX	XXXXX	XX	XX	XX	XX	XX	XX	
B	01	10	ARPA9	20	2					
G	01	10	UGA	10						
B	02	10	ARPA9	15	3					
B	02	10	CHCO2	40	1					
G	02	10	UGA	10						
B	03	10	ARPA9	40	2					
G	03	10	UGA	10						
H	04	10	QUKE	10	7	1	3	3		
B	04	10	ARPA9	5	1					
B	05	10	ARPA9	15	3					
G	05	10	UGA	5						
B	06	10	CEIN3	15	4					
B	06	10	ARPA9	10	1					
G	06	10	UGP	20						
B	06	10	CEIN3	5	3					
B	07	10	ARPA9	25	2					
H	08	10	QUWI	20	9	3	2c	3		ROCKY AREA
B	08	10	ARPA9	10	2					
B	09	10	CEIN3	10	3					
B	10	10	ARPA9	15	2					
G	10	10	UGA	30						
B	11	10	CEIN3	15	3					
B	11	10	ARPA9	5	3					
B	12	10	ARPA9	20	2					
B	13	10	CEVE3	15	1					
G	13	10	UGA	30						
B	14	10	ARPA9	5	3					
B	15	10	CEIN3	25	3					
G	15	10	UGP	30						